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THE CONSTRUCTION OF LARGE DYNAMOS.

IT has been frequently stated that there is nothing very difficult in the construction of large direct current generators, and certainly with the experience which manufacturers have gained, one might naturally conclude that most of the mechanical and electrical difficulties would have been by this time overcome. But in spite of these assumptions, one hears so many sinister rumours at times of the inefficiency of, and the repairs necessary on, certain large machines, that one becomes at last convinced that there are certain troubles to which such machines are especially prone. It must be remembered that as far as British manufacturers are concerned, it is only within the last few years that there has been a demand for machines having a greater capacity than 300 KW. In America, however, the necessity for large generators, both for lighting and tramway work, has existed for a long time, and this fact has enabled American manufacturers to get a little ahead in the matter of experience. This circumstance has given American firms an important advantage over their British competitors, not only on the markets of the world, but even in this country, and they have made the most of the opportunity. In the stress of business competition it may be perfectly legitimate to decry the goods of rival manufacturers, but it is not wise, and it is occasionally dangerous to do so. It not infrequently disgusts the buyer, and defeats the objects of the seller.

There is no doubt that American and Continental plant has been very much boomed in this country; probably intelligent and systematic advertising has been responsible for a good deal of this, but there has been a tendency among buyers to presume that home-made plant is not quite as good as that which comes from abroad. No one could begrudge the praise that has been awarded to foreign firms, but we do not think this ought to be done at the expense of English manufacturers, especially when we consider they are not much behind either Continental or American firms. It is for the good of everybody that the chief features of foreign design should be duly recognised, and if good it is only proper that they should be adopted; but one is inclined to protest against the presumption that because a machine is foreign it is necessarily perfect. We do not say that everybody indulges in so foolish a conclusion, but we have certainly noticed that many leading authorities are inclined to overrate the qualities of foreign-made dynamos, and underrate home-made products. Much time and eloquence has been spent of late in dilating upon the features of large dynamos, made by Continental firms, at the Paris Exhibition, but though there were some excellent examples of English machines, they are scarcely mentioned. We are quite aware that one might find little difficulty in pointing to machines that were

ment described may be used as a watt-meter, the windings on the laminated field magnet being supplied from a transformer, the primary of which carries

charged. By this means the accumulators receive their current exclusively for the purpose of working the motors. I claim,

unsatisfactory, but then, have either American or Continental machines which have been introduced into this country been wholly free from trouble? On the contrary, the performance of some has been anything but satisfactory, yet, for some reason or other, attention has not been very closely directed to them. At the same time, one would not be justified in concluding that because there were some unsatisfactory examples of foreign-made machines, any general rule could be drawn.

The main point we want to insist on is that if British manufacturers get a fair chance they will turn out machinery that in every sense is equal, and may be superior, to foreign products. Probably they have been a little backward in meeting the requirements of the times, and certainly there are plenty of people who argue that the conservative methods of the average British contractor render him incapable of offering a successful resistance to foreign competition. The British manufacturer is neither as bad nor as good as he has been painted, but he needed a bit of shaking. As a nation our pride has passed through a severe ordeal in South Africa, but it is clear that it has done us the greatest good in the world. In some such way foreign competition in electrical work has already convinced home manufacturers that they must put their house in order, and as soon as they have completed that operation we feel sure they will render a good account of themselves.

In the construction of all large generators, whether for continuous or alternating current, the chief difficulties are probably mechanical. In direct current machines with large commutators the electrical problems are somewhat intricate, and the design of the commutator necessitates a certain amount of care and foresight. We believe we are correct in saying that the troubles that have arisen in large direct current machines have been mainly confined to the commutator; the collection has been occasionally troublesome, but, comparatively speaking, the difficulties have been of a minor character. Little need be said on the subject of constructing single-phase alternators, for that, at any rate, is one branch of electrical work where English manufacturers have distinguished themselves; we do not say the largest machines have been built in this country, for we have probably nothing to compare in size with some Continental machines, but in spite of this we think it has been clearly shown that in the construction of large alternators we have little to learn from our foreign rivals.

On the subject of three-phase machinery the English manufacturer occupies a wholly anomalous position, for English-made machinery of this character is practically non-existent. It cannot be that English manufacturers avoid this work on account of difficulties in the making, because from a shop point of view they are simple machines, especially when compared with a continuous current generator. Nor can the question of patent rights be an important factor in the case. We suppose the real reason of this strange aloofness arises from an indisposition to recognise the demand for this class of machinery. There are many who have in season and out of season proclaimed that three-phase working was but a passing craze, which would die out as quickly as it came into being, but so far from that being the case, additions are constantly being made to the already lengthy list of electrical schemes which employ three-phase machinery. In the provinces, Dublin, Manchester, Glasgow, Brighton, Stockton and Middlesbrough tramways have adopted such systems, while in London there are, or soon will be, six examples of polyphase transmission. The Central London Railway, the Metropolitan Supply Company, the Kensington and Knightsbridge *cum* Notting Hill, St. James's and Pall Mall *cum* Westminster, Blackheath and Greenwich, and the County of London Company, are all committed to polyphase machinery, and certainly the systems upon which these concerns are spending large sums of money would hardly be based on a passing craze. In all these cases, with probably two exceptions, the whole of the machinery will be imported from abroad. It is not gratifying that such should be the case, and it certainly shows how English manufacturers have neglected the home markets.

For some time, at any rate, we shall probably witness in three-phase work a repetition of what occurred in tramway work. Practically the whole of the electric tramways in this country have been equipped at least in part with foreign plant, few of our home manufacturers having been able to graft the construction of tramway equipment on to their business, and, unless we are mistaken, we are about to witness a similar state of affairs in regard to three-phase work. It may not become so pronounced if English manufacturers rouse themselves in time, but unless they do so they may eventually find themselves in the position of Othello.

Edison and the Press.—Edison and Tesla are names to conjure with in the daily press, both English and American. A great deal has been appearing lately about Mr. Edison's "latest," but Edison himself says it isn't out yet. In reference to the newspaper report to the effect that he had invented a new machine for the generation of electricity directly from coal without the intervention of engine, boiler, or dynamo, with a prediction that it would revolutionise the world in electrical matters, Mr. Edison is reported by the New York *Electrical World* as saying: "It is a lie and a fake. There is not a word of truth in it from beginning to end." To be misrepresented is one of the privileges of scientific greatness.

Electrical Lectures for Colliery Engineers.—The Council of the North of England Institute of Mining and Mechanical Engineers, in collaboration with the Council of the Durham College of Science, have arranged a course of lectures for colliery engineers, enginewrights, apprentice mechanics, and others, to be delivered at the Durham College of Science, Newcastle-upon-Tyne. The course will extend over three winter sessions, and involves attendance for 24 Saturday afternoons. The delivery of the next course of lectures will commence on October 6th, 1900. A brief syllabus has been issued of the three years' course. Electricity will form the subject for one term as follows:—1901-2. Michaelmas Term. — Theoretical Electricity. — Lecturer, Mr. R. J. Patterson, M.Sc. Electrical Engineering. —Lecturer, Mr. W. M. Thornton, M.Sc.

Central Technical College Old Students' Association.—The third annual dinner of the Association of Old Students of the Central Technical College will be held on Tuesday, October 2nd, at the Restaurant Frascati, Oxford Street. Old Students can obtain further particulars from the honorary secretary, Mr. M. Solomon, 12, Edith Road, West Kensington, W., to whom all applications for tickets should be made.

MOTOR-DRIVEN LATHES.

The most usual way of driving lathes is in groups, each lathe deriving its power through a countershaft off the main shafting. Even in shops where motors are extensively used this is the plan usually adopted, the reason being that small lathes will often not warrant the extra expenditure of a motor to each, while most modern lathes, especially those built on American lines, require a countershaft and line shaft to get the large number of speeds necessary. Consequently, except in the case of large tools, grouping is the system usually adopted.

Fig. 1.—One of the Lathe Bays in Messrs. Crompton's Shop at Chelmsford.

There are, however, many cases where a motor to each lathe will pay for itself; the motor complete, with its own countershafting and cone pulley, being fixed above the lathe, as shown in fig. 1.

This arrangement possesses several advantages. In the first place, the lathes can be arranged at right angles to the usual position, and this allows the overhead traveller to attend to any single tool without interfering with a neighbouring one. Then, in a bay of this description, not more than half the tools are usually at work at one time, and consequently the power is cut off from those at rest, and the stand-by losses are reduced to a minimum.

Another method of driving lathes, in which the same machine-tool motor is made use of, is shown in fig. 2. The motor in this case stands on the ground, and belt drives direct on to the cone pulleys of the lathe. This arrangement lends itself specially to extensions in existing shops.

A novel method of motor driving, namely, a self-contained motor lathe, is shown in fig. 3. The motor is fixed in the pedestal of the lathe, and in this way the lathe occupies little or no more floor space than an ordinary lathe.

There is sufficient room inside the pedestal of an ordinary lathe to contain a motor, but hitherto the difficulty has been to obtain the necessary speed variations which are usually given by the cone pulleys. There is certainly not sufficient room inside the pedestal to contain a motor complete with its own countershafting and cone pulleys, and consequently a special gear has had to be designed and worked out, and the details of this are shown in fig. 3.

The space usually occupied by the cone pulleys is here made use of for four chain pulleys of different sizes, which are fixed on a spindle.

Directly underneath a second and similar spindle is fixed, with similar chain pulleys, but arranged in the opposite direction, viz., the largest opposite the smallest, and so on.

In this way four different speeds are obtained, the power being transmitted from the one shaft to the other by means of Hans Renold chains, which run in an enclosed oil bath. The motor is fitted with a countershaft, and this spur drives direct on to the lower of the two chain pulley shafts. A chain connects each of the four pairs of pulleys, but only the one pair in use is turning round, the remaining three pairs being out of gear and motionless.

The speed of the lathe is varied by throwing into gear another set of pulleys, and this is done by means of a ½-inch spindle, which projects on the front of the lathe; the operation consists in pulling out or pushing in this spindle.

From this it will be gathered that the turner can vary the speed of his lathe, without moving out of the position he usually occupies when at work.

This may seem a small matter—but the fact that the workman can change the speed of his lathe with one hand, and in his working position, has some practical value.

In laying out new shops a lathe of this description will be valuable; it need not be used throughout—and most probably would not be—but positions will present themselves where a lathe requiring no overhead gear will be useful.

The lathe in question, self-contained with motor and variable speed gear, has been in continual use for some months past, and it has been found that the motor and gear runs well, and that the tool is more within the control of the turner than an ordinary lathe deriving its power from a line shaft.

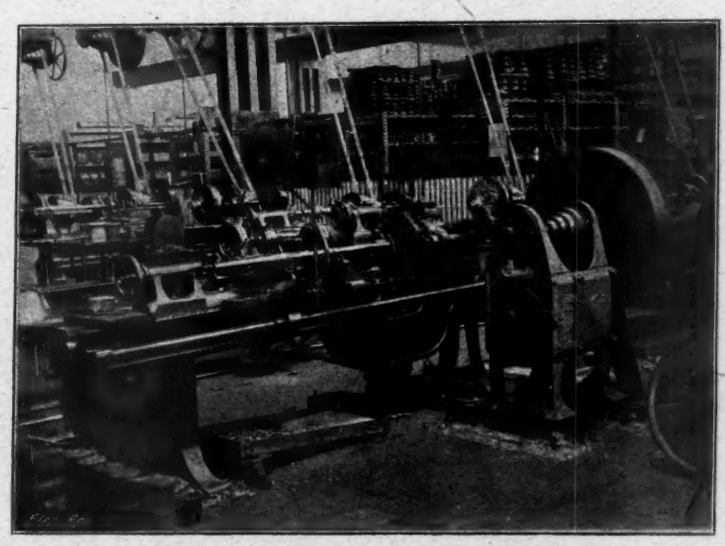


Fig. 2.—Crompton's Machine Tool Motor driving Isolated Lathe.

It was feared that possibly the motor might suffer from strains and jerks transmitted through the gearing from the cutting tool.

This, however, has proved not to be the case, which shows that the chain acts much in the same way that a belt does, and damps down to some extent any sudden strains which would have been transmitted had gearing been used in place of chains.

D

Of the different methods of driving lathes described above, each will find a use in practice. In some positions the overhead arrangement will be best, in others the self-contained tool.

One thing is certain. In laying out a new machine shop, full advantage must be taken of the possibilities of motor driving, either by the "grouping" system or by independent motor driving, and the general plan of floor space and arrangement of roof must be got out accordingly.

The maximum economies cannot be expected if the shop is first built and the arrangement of tools got out afterwards.

One of the great advantages of motor driving lies in the flexibility of the system, and in a possible arrangement of the tools which no other method of driving affords.

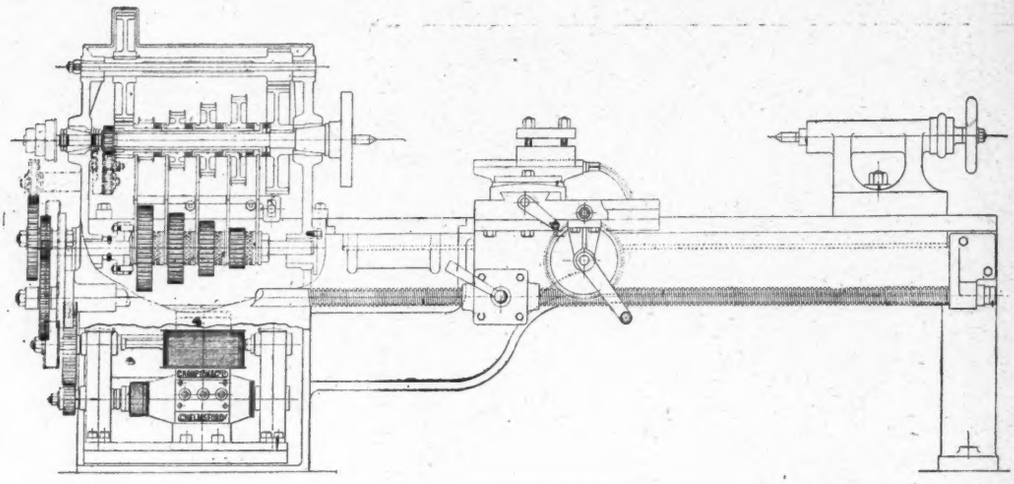


Fig. 3.—Self-Contained Motor Lathe.

INDISPENSABLE ACCESSORIES OF ELECTRIC TRACTION.

By HENRY E. P. COTTRELL, A.M.I.C.E.

(*Concluded from page* 299.)

Composite hangers which form part and parcel of the ears or clips are used for special cases, such as section insulators, right angle crossings, diagonal crossings, and frogs.

Section insulators are employed to divide up the trolley wire into sections, so that when necessary any part of the line can be cut out without interfering with the remaining sections. The straight under-running section insulator consists of two terminal ears united by a wooden bar, which can be removed and replaced without interfering with the line; connected with these ears are two elbows with combination clamps, through which the ends of the line wire are passed, enough being left coiled over to let out for repairs. These elbows are united by a conducting bridge and an insulated bar, in the centre of which is a double pull-off. The upper part of the clamps is designed to hold the insulated feeder wires in such a way that the insulation can be left, except in the part held by the clamp, intact from poles to section insulator and between the lines where there is a double track. Another useful form of slightly different construction is that in which the crossings and frogs are provided with flanges and projections to guide the trolley shieve when travelling across and through them. They are also provided with double pull-offs, and are adjustable to varying angles by clamping screws. Each wing forms a terminal ear or clip to which the ends of the wires are soldered in the ordinary way. These frogs and crossings are anchored by special insulated pull-offs, of which the Globe strain form may be cited as an example.

Span wires for supporting the hangers are themselves insulated from the poles or rosettes, to which they are fastened to afford the protection of double insulation to the trolley wire, as in the case of the double insulation bracket sleeve previously described. This is effected by the use of strain insulators with uninsulated or insulated turnbuckles. The insulated turnbuckles are extremely useful in adjusting the tension in span wires, for as much as 6 inches of slack can be taken up by a pair. Larger sizes are made for corner poles where a number of pull-off wires are carried, and for terminals of the trolley wire.

The results of tests carried out by the late Dr. John Hopkinson, F.R.S., for the Liverpool Corporation on "Globe" pole insulators and "King" turnbuckles are tabulated hereunder :—

Description.	Breaking load.	Remarks.
"Globe" pole ...	4,562 to 5,040 lbs.	Started.
Insulator ...	4,693 to 5,398	Broke through the eye.
King turnbuckle	9,350 to 9,742	Broke across screw, insulating material started breaking at from 60 to 70 cwt.; insulation in no case forced out entirely. Metallic fracture sound.

There are special forms of trolley wire clamps for use at terminals used where an ordinary wire loop is not sufficient to hold the strain. In special cases where trolley wires fed from separated sources of power have to be crossed, an insulated crossing is used in which the ears for the two lines are back to back, one wire running over and the other under the crossing, both being soldered in place.

The splicing of the trolley wire at splicing ears is by far the best way of uniting it, but it is often accompanied by considerable waste. This is avoided by using splicing sleeves which are copper tubes with tapering ends and a central screwed joint. In one form the wire is wedged and soldered in, while in another the ends are set up and fit in behind a screwed junction piece. Another necessary adjunct are copper protective sleeves which are used in the neighbourhood of frogs and crossings, section insulators, &c., and are slipped over the wire on which they fit as tightly as possible. The table on page 493 shows the name and approximate quantities of the material and adjuncts required for one mile of overhead line construction, with their approximate weight.

By this table it will be seen that bracket suspension involves the same weight of material and accessories (exclusive of poles) as cross suspension for double tracks, but under

Table of the Amount and Weight of Material and Accessories Required for an Ordinary Overhead Line.

TABLE OF THE AMOUNT AND WEIGHT OF MATERIAL AND ACCESSORIES REQUIRED FOR AN ORDINARY OVERHEAD LINE.

Description.	Cross suspension.		Bracket arm suspension.		Simple curve.		Compound curve.		Anchoring.		One turn out, 200 feet length.	Total number.		Weight of each.	Total weight.			
															Cross suspension.		Bracket suspension.	
	Single track.	Double track.	Single track.	Double track.	Single track.	Double track.	Single track.	Double track.	Single track.	Double track.		Single track.	Double track.		Single track.	Double track.	Single track.	Double track.
														lbs.	lbs.	lbs.	lbs.	lbs.
Insulators, straight line	46	92	...	...	...	...	...	...	...	...	...	46	92	24	126½	253	...	...
,, single pull off	...	...	...	...	3	3	3	5	...	...	...	6	8	24	17	22½	...	...
,, double pull off	...	...	...	...	4	11	3	12	...	...	4	7	23	24	22½	73	...	...
,, bracket arm	...	...	45	90	...	...	...	...	...	...	...	45	90	8¼	...	...	493½	987
Frogs	...	...	...	...	1	2	...	...	...	...	...	1	2	6	6	12	6	12
Ears, plain	45	90	44	88	5	10	5	15	...	...	4	C.S. 59 B.S. 58	119 117	2	44½	89½	43½	88
,, strain	...	...	...	...	2	4	1	2	...	...	...	3	6	7	2½	5	2½	5
,, splicing	1	2	1	2	...	...	...	...	...	...	...	1	2	14	1½	3	1½	3
Strain insulators ...	92	92	...	...	4	4	2	2	1	2	8	101	107	5¾	581	615	...	...
Insulated turnbuckles	...	...	...	...	4	4	2	2	1	2	...	7	8	1¾	13	15	13	15
,, pull off	...	...	...	...	...	...	2	6	...	...	4	6	10	14	7½	12½	7½	12½
Crossing	...	...	...	...	...	...	...	1	...	...	...	0	1	8	...	8	...	8
Uninsulated turn buckles	46	46	...	...	...	...	...	...	2	...	4	52	52	1	52	52	...	...
Number of poles	90	90	45	45	2	2	2	2	...	2	2	C.S. 96 B.S. 48	96 48	C.S. 670 B.S. 750	64,320	64,320	36,000	33,600
Suspension wire, in feet	3,000	3,000	...	...	800	800	800	800	500	500	100	4,400 feet	4,400 feet	21 per 100 feet	921	921	...	...
Trolley wire, in feet	5,280	10,560	5,280	10,560	...	...	...	...	...	...	100	5,680 feet	10,960 feet	1,429 per mile	1,429	2,858	1,429	2,858
Total weight per span, exclusive poles	29 lbs.	36 lbs.	18 lbs.	36lbs.	spans 110 ft.													
,, with poles ...	614 lbs.	630 lbs.	345 lbs.	363lbs.														
														Total, exclusive poles	3,224	3,939½	1,996½	3,988½
														,, inclusive ,, ...	67,544	69,259½	35,596½	37,588½

two-thirds for single tracks. When the weight of poles is added, the weight of material for an overhead line involved in cross suspension as compared with bracket suspension, is 7 to 4 (nearly) for both single and double lines, so that apart from the question of appearance and of convenience from the point of view of construction, there can be no question as to the superior economy of the parallel system of suspension when compared with the older axial system.

In America far more latitude is allowed in the question of choice of poles to support an overhead line than would be tolerated in Great Britain. Poles of chesnut, cedar, and Georgia pine are in general use outside the limits of the more important towns, and even there they have not been wholly replaced as yet by iron ones, while on this side none but mild steel or iron tubular or conical poles are used. All poles must be of sufficient lateral strength to stand without permanent set the maximum strains to which they may be subjected when in position. The following table shows these strains for ordinary practice :—

	Lbs.	Lbs.
Cross suspension single track	500 to	1,200
,, ,, double ,, ...	750 to	2,000
Bracket suspension, single and double track	500 to	1,200

The amount of allowable deflection under these strains must not exceed 4 to 6 inches in poles 31 feet high. There must be also a sufficient margin of strength allowed to support the additional weight when the trolley wires are covered with ice and snow. The strain on poles round curves being greatest, additional stiffness should be afforded by giving them a slight rake away from the centre of the curve. With axial suspension, the side poles should always have a slight outward rake even when given concrete foundations, as is the town practice in Great Britain, and when they are bedded in earth this should be increased to from 6 inches to 18 inches away from the track. Central poles between tracks of course should be plumb. Poles should be planted from 4 to 6 feet in the ground; they should be as nearly cylindrical as possible and taper from butt to head. Their cross-sections should be accurately circular, and to ensure uniformity in this respect one-tenth of an inch margin only should be allowed on either side of the prescribed dimensions. The greatest departure from the true rectilinear central axis at the top should not exceed $\frac{1}{4}$ inch. The poles in general use are built of three tubular sections which are lap-welded and in the larger sizes rivetted along the lapweld with countersunk rivets. These sections are put together so that the seams of each consecutive section are placed 120° apart. The joints are made by heating the outside pipe to a welding heat and slipping it over the inner pipe and then passing the pole through special rollers, which ensures the pole not giving way at the joints after erection. If the joint thus made be cut through and examined, it will be found the sections are practically welded together, the joining line being almost wholly obliterated. Tested under service conditions over a considerable period, these poles have been found to stand the determined strains with the calculated limited temporary and permanent deflection, and to stand the constant vibration of the trolley wire without any deterioration in the joints; in fact, to behave precisely as if they were rolled from one piece and without seam. The details of the poles such as ornamental base and the scroll work of the brackets may be varied indefinitely, but should be carefully thought out so as to harmonise with the best standard for lamp-posts in the town where they are to be erected, as this largely does away with æsthetical objections. In Bristol and Dublin, in accordance with the best American practice, five sizes of poles were provided calculated to stand various strains with prescribed maximum temporary deflection and permanent set, as shown in the following table, the poles being all 31 feet in length :—

Ouside Diameter.	Thickness.	Length.	Weight.	Load for temporary deflection.	Deflection.	Load for permanent set.	Set.
in.	in.		lbs.	lbs.	in.	lbs.	in.
7 × 4	$\frac{5}{16}$	31	620	350	6	700	$\frac{1}{2}$
7 × 4	$\frac{3}{8}$	31	720	500	6	1,000	$\frac{1}{2}$
7 × 4	$\frac{7}{16}$	31	900	700	6	1,200	$\frac{1}{2}$
8 × 5	$\frac{7}{16}$	31	1,100	1,000	6	1,700	$\frac{1}{2}$
10 × 5½	$\frac{7}{16}$	31	1,500	2,000	6	2,600	$\frac{1}{2}$

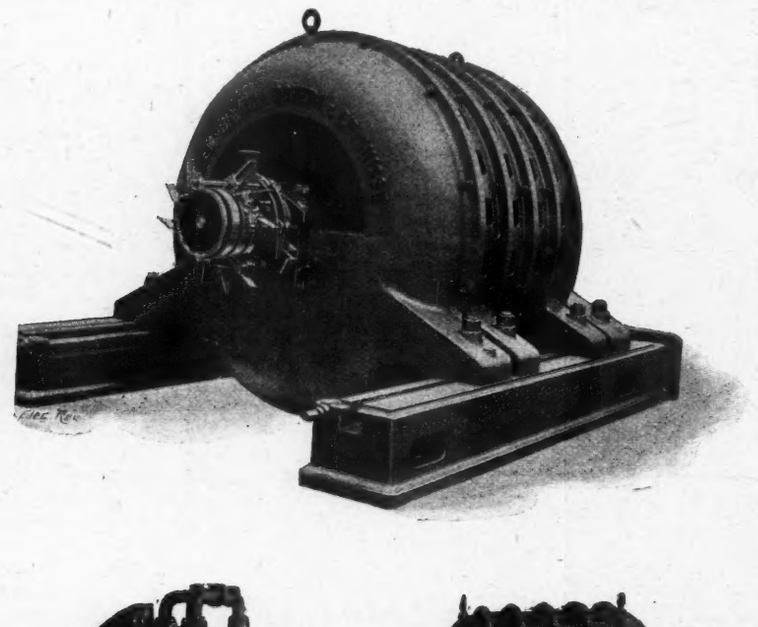
The test to which these were subjected was to be dropped thrice, butt foremost, from a height of 6 feet upon a solid substance, and the small percentage showing any sign of telescoping or loosening of the joints were rejected. The insulation of the top of the poles from the ground and wires leading thereto, is effected by inserting a wooden plug in the top of the poles to which the span wires and guy wires are attached. In bracket poles the insulation is provided in the sleeves from which the insulated hangers are suspended.

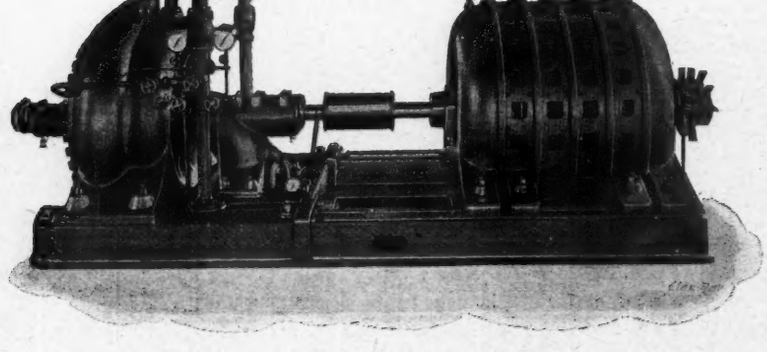
In suburban and interurban lines the German style of latticed pole is most appropriate, and will no doubt be more and more adopted on account of its relatively lower cost.

Experience has conclusively demonstrated that there can be no valid objection to a carefully designed and erected line with sub-surface feeders, handsome poles, &c. All the municipal commissions from our great towns which have visited Continental and American cities to study the question of electric traction on tramways, have invariably pronounced in favour of the trolley wire overhead system against all others, and most corporations have ceased to view this system with disfavour, so that it would not be a surprise if it were shortly to be introduced within the limits of the metropolis itself. Bristol, Dublin, Leeds, Bradford, Liverpool, Glasgow, &c., have all adopted it with satisfaction to everyone concerned.

THE LARGEST INDUCTION MOTOR IN THE WORLD.

We illustrate herewith a 1,000-H.P. two-phase 5,000 volts induction motor by Brown, Boveri & Co., driving a centrifugal pump at 455 revolutions per minute, the set being used at the Geneva Water Works for pumping water to a height of 460 feet. Not the least remarkable feature of the combination is that a centrifugal pump should be successfully employed for throwing water to so great a height. It almost looks as if the days of the reciprocating pump are on the wane.





INTERIOR WIRING.

By G. C. ALLINGHAM.

For several years there has been an agitation in favour of concentric wiring with an uninsulated outer conductor, and great efforts have been made to convince central station engineers of the advantages of this system of wiring. But the central station engineers apparently remain unconvinced. It has always appeared to me that the advocates of wiring with uninsulated return look at the question more from the point of view of the wireman (or perhaps I should rather say of the "wiring engineer") than from that of the central station engineer. They hardly seem to realise that the wiring of a building which is supplied from street mains is electrically a part of the distributing network of the central station. If we look at the wiring of a building by itself, and exclude from our consideration anything outside that building, the concentric system of wiring with uninsulated outer undoubtedly has advantages, but, as I shall show presently, these advantages are by no means peculiar to this system. On the other hand, if we regard the distributing system as a whole, by which I mean the whole of the network, from the central station or sub-stations, as the case may be, to the lamps, the use of uninsulated return conductors is open to many objections.

The very property that is claimed, and justly so, as *the* great advantage of concentric wiring, namely, that any fault is bound to become a dead short circuit, is a serious disadvantage when we have to deal with a large distributing system, as Mr. Wordingham pointed out in his M.E.A. paper this year. In the case of a three-wire network, with earthed return conductors connected to the middle wire, a single earth on either of the outers will dead short the mains, and interrupt the supply until it can be cut out or burnt out, and it is evident that the danger of interruption of the supply will be much greater in such a case than if the system be entirely insulated from earth, or the middle wire be earthed only at the station, so that it can be temporarily disconnected from earth in case of a fault on one of the outers.

Again, on a large network, different parts even of the middle wire of a three-wire system may be at considerably different potentials, and if uninsulated returns were used, considerable currents might return through the earth and cause electrolytic troubles. Excepting at Guildford, where the system is a very small one, no wiring with uninsulated returns has yet been carried out, except in isolated installations supplied by their own dynamos, or by separate transformers, so that it is impossible to say from actual experience whether the electrolytic trouble is likely to be a serious one or no, but experience with the earth returns of electric tramways shows the kind of thing that would be likely to happen. It is true that the drop of voltage on the uninsulated return of a distributing network would probably be less than that on the earthed return of a tramway; but on the other hand,

the surface of the uninsulated outer would be very great, and inside a building a comparatively small amount of electrolysis (of a gas-pipe for instance) might do a great deal of damage. Again, there is a danger of the bare outer conductor itself being eaten through, and the breaking of the outer conductor might quite conceivably cause a fire.

At Guildford, although the middle wire of the street mains is bare, it is carefully embedded in bitumen throughout, and in the consumers' premises, which are wired with concentric cable with a bare outer conductor, care has been taken to keep the bare outer out of contact with any gas or water pipes; so that, although a bare outer conductor is used, a sort of attempt is made to insulate it from earth. Is not this a confession of weakness?

The principal advantage usually claimed for concentric wiring is its safety, since the outer exposed conductor is earthed, and it is therefore impossible to get a shock, and any fault must either be a short circuit, or quickly develop into a short circuit, which blows the fuse and cuts off the current until the fault is removed, so that it is impossible for any fault to endure and to cause fire or other damage. What I wish to point out, however, is that exactly the same properties are possessed by *any* metal-sheathed system of wiring with both conductors insulated, provided that the metal sheathing is made electrically continuous throughout, and is efficiently earthed, and that one of the wires is earthed at one point either continuously or at frequent intervals.

With such a system of wiring, properly carried out, any fault on either wire is bound to form a connection between it and the metal sheathing, and so earth it, either instantly or very soon, and in any event before any external damage can be done. Now if, for example, the wiring be connected to the neutral and one outer, say the positive, of a three-wire network, the middle wire of which is earthed at the station, any fault on the positive conductor of the wiring will produce a short circuit, and blow a fuse, and so cut off the faulty conductor until it is repaired. As the negative conductor of the wiring is at or near earth potential, any fault that might occur on it is not likely to be dangerous, but such a fault could not last long if, at intervals, the outers were alternately earthed at the station, the middle wire being, of course, temporarily disconnected from earth meanwhile.

I consider that the greatest possible safety with house wiring would be attained by using double wiring, enclosed throughout in earthed metal sheathing, connected to three-wire mains having a removable earth connection on the middle wire at the station, and by earthing each of the outers (while the middle wire is temporarily disconnected from earth) for a minute or so regularly every day. Any fault in a consumer's installation on either of the outers would instantly cut itself off, and any fault on the neutral would cut itself off next time the outers were earthed at the station, so that the consumer's wiring would be perfectly "self-testing," just as concentric wiring is, and at the same time it would be free from the objections to concentric wiring.

Even where the middle wire is not earthed, almost absolute safety would be attained by earthing each main at the station every day, for a fault on house wiring can hardly do much damage in 24 hours; the damage done by faults is nearly always very gradual, and the catastrophe does not occur until the mischief has been going on for many days or weeks.

It is evident that, to attain safety, the metal sheathing of the wiring must be electrically connected together throughout; in fact, if this is not done, the metal sheathing may constitute a danger rather than a protection, for if a fault occurs on one of the wires, which thus becomes connected to the sheathing, a portion of the latter may become charged above (or below) earth potential, and give people shocks, or, if it touches a gaspipe, it may arc to it, and in time burn a hole in it and ignite the escaping gas.

This is the great defect of the system of wiring in steel conduits with sleeve-joints, which has been recently introduced, for the sleeves do not make a good electrical connection between the lengths of tube, and therefore, in my opinion, this system is not to be recommended on the score of safety; the requisite conditions may, however, be fulfilled by the use of iron or steel tubes with screwed couplings, or by lead-covered wires.

My own idea is that lead-covered wires with fibrous insulation are likely to come very much more into use for house work in the near future. They have already almost entirely superseded vulcanised rubber-insulated cables for underground mains, for which purpose they have been found to be cheaper and more durable, and what is true for underground mains is also true for interior wiring. Those who have to do with house wiring do not generally seem to realise that a lead-covered fibre-insulated cable is much cheaper than an ordinary braided or taped rubber-insulated cable, and that this applies just as much to the smallest sizes of cables as to larger ones, while the lead-covered cable has the further advantage that it can be run without further protection in many places. The price of rubber has been rising steadily for years past, and the rise appears to be likely to continue in the future, so that the saving in cost by using fibre-insulated cables is likely to increase still further. It is now generally recognised that fibre-insulated lead-covered cables are more durable than vulcanised rubber-insulated ones for underground work, where the conditions are very much more severe than in housework, so that it is not probable that fibre-insulated cables will be found wanting in durability in interior wiring.

The objection to fibre-insulated cables is that the insulation is hygroscopic, and for this reason the ends of underground cables of this class are enclosed in boxes filled with compound in order to make a watertight seal, and it would be very difficult to effectively seal the ends of all the cables in the wiring of a building in this manner. But my own experience has been that, except in unusually damp buildings, there is no danger of the insulation being damaged by absorption of moisture. I have wired new houses with lead-covered fibre-insulated cables, and left the ends just as they were cut off, without sealing them in any way, to the tender mercies of the plasterers, who have often broken the lead coverings of the projecting ends, and yet I have had no single instance of a cable absorbing damp. The only trouble I have had is with surface leakage, which is always greater with metal-sheathed systems of wiring than when no metal sheathing is used, since the sheathing itself forms a good earth close to the bare terminals on the fittings, and shortens the path of the leakage current. This surface leakage sometimes makes it impossible to attain at first in a new house the insulation resistance required by the rules of the supply authorities, but after the house has been occupied for a few weeks, and has become dry, the insulation resistance increases to the normal figure. The surface leakage is no greater with fibre-insulated than with rubber-insulated wires, whether the latter be lead-covered or run in metal tubing, and it is not by any means necessarily an indication of a defect in the wiring; in fact, as I have just pointed out, the systems of wiring which are the safest have the greatest tendency to surface leakage, and the "figure of merit" of an installation is not only not proportional to, but may even be an inverse function of, its insulation resistance. Again, I have found that, with metal-sheathed wiring, the insulation resistance often varies with the weather.

I have usually covered the ends of fibre-insulated house-wires with lappings of insulating strip, such as "okonite" tape, or with rubber tubing, which I have found quite sufficient protection in ordinary interior wiring. The lead coverings of the wires are easily connected together by copper wires soldered to them with a blowpipe.

Some classes of fibre-insulated cables, particularly paper cables, are impregnated with oil, which gives trouble by becoming fluid in hot weather and running out of the ends of the cables and spoiling the wallpaper. Cables for indoor work should be impregnated with a more solid compound, which will not melt in the hottest summer weather, and there are many fibre-insulated cables made which give no trouble in this respect.

The use of lead-covered cables gives a very "flexible" system of wiring. In many cases the wires can be run with safety without further protection, and they can be drawn or "fished" under floors, behind partitions, and through all kinds of narrow places in a way that would be impossible otherwise; they can be cleated up on the surface, and often most inconspicuously, as they can

used at the Geneva Water Works for pumping water to a

on the earthed return of a tramway; but on the other hand,

be run in corners and along edges. Where extra mechanical protection is required, the lead-covered cables may be run in iron or steel tubing, and I have found "Simplex," and similar tubing, excellent for this purpose; they can be run on the surface in ordinary wood casing where its appearance is preferred; the lead covering can be additionally protected against corrosion or abrasion where necessary by taping or braiding and compounding; for rough work the cables can be armoured with steel wire or strip; and where they are especially exposed to corrosion they can be run in troughing filled with compound. In fact, wiring with fibre-insulated lead-covered cable may be carried out so as to suit the most varied classes of work, and so as to make a sound job under almost any conceivable conditions, and it therefore seems to me probable that this class of cable will, in the future, become the standard for interior wiring, as it may almost be said to have already become for underground mains.

STEEL: ITS PROPERTIES AND TESTS.

III.

The daily practice of the 33 firms making over 75 per cent. of the open hearth and Bessemer steel of America must be but briefly summarised. These 33 firms have 73 testing machines of from 130,000 to 400,000 lbs. capacity; 62 are screw operated, and 11 are hydraulic. Both methods permit of action without shock. The poise may be fed by hand with all practical convenience. The Commission of 1891 (French) and the International Conventions of Munich, 1884 and 1885, Dresden, 1886, Berlin, 1890, and Vienna, 1893, are explicit as to fixing test pieces so as to obtain uniform distribution of strain and proper clamping without the use of serrated wedges to cut into the specimen. The French Commission did not, however, forbid the latter. The 33 American companies, on the contrary, do not use the pin connection, and do use wedges, crown faced, and diagonally serrated. This allows the specimen to align itself, and saves the edges from cutting. Ball-bearing grips fail by dirt and scale, and have been abandoned. The general opinion limits speed to 3 inches per minute, and considers that the difference between 1 and 3 inches is not so great as the variation in specimens and the errors of observation, so that for commercial work speed is of small moment. Rapid tests show higher tenacity but less elongation. Specimens are callipered to ·001 inch. On a ½-inch piece this represents 320 lbs. on 80,000 lbs., or 241 lbs. on 60,000 lbs. steel in the specimen of fig. 2. This is American practice, and is more accurate than the Conventions demand.

The American practice of reading loads to within 100 lbs. is as accurate as the limits asked by the Conventions or Commission, for actual loads on a ½-inch steel specimen usually exceed 10,000 lbs. Elongation is measured to ·01 inch, which is only ·50 per cent. on a 2-inch specimen with 20 per cent. elongation, or ·125 per cent. on an 8-inch specimen of 25 per cent. quality. Reduction of area is measured to ·01 inch by the majority. Nearly half of them measure to ·001 inch or to ·33 per cent. of a 20 per cent. contraction on a ½-inch specimen.

Yield point is determined by the drop in the beam or the bolt in the pressure gauge, as a rule. Special accuracy when wanted is got by a special apparatus attached to the specimen. Bending is apt to be roughly done in America, even by the hammer.

The testing of every piece, such as axles, for example, by such a test as not to injure it is not much done in America, nor is its utility very apparent.

The chemical tests hardly admit of brief abstraction but are fully detailed.

An interesting subject to electrical engineers is that of rails. The growth of the American export trade in rails has been recent and rapid. It stood at 12,229 tons in 1894, dropped to 8,807 the next year, and rose rapidly to 291,038 in 1898, again dropping to 171,272 tons last year. This trade is, we believe, still something of an overflow trade, but its existence in competition with English, German, and Belgian rails certainly gives colour to the claim that owing to their high tariff Americans are paying more for rails than the foreign customers of American rail makers. Reviewing a number of foreign specifications of rails, the author found that one in five limited the material to English or Spanish hematite pig and charcoal spiegeleisen, requirements not within the power of American mills to comply with. The carbon when specified had a range of ·10 to ·15 per cent., which resembles American practice. Rapid rolling, of course, enables a higher percentage of carbon to be specified. For tramway work on British methods, the rail supported continuously on concrete, there is no need for a rail to be strong as a girder in the sense that it must be strong on a sleepered railroad where the rail carries a weight applied between points 2 to 3 feet apart. Hence tramway rails may be made as hard as consistent with ability to bear "jimming." Because of differences in the rolling of rails there can be no standard specification of the chemistry of a rail. This must be changed to suit the conditions of manufacture. American rails are faulty in that they rarely contain less than 0·10 of phosphorus, as against the 0·06 or less of European practice. Engineers who order American rails just as it pleases the maker to send them over, should bear in mind that the same liberal allowances in phosphorus and in sulphur would enable our own makers also to supply a cheaper and second-rate article. The author claims that the excessive phosphorus of American rails has not, in "the opinion of many competent judges in America," given a rail whose extra cheapness is marred by any corresponding danger.

Campbell, however, we may remark, on whom the author relies on other points, states that it is not very costly to reduce phosphorus, and for basic steel he would even specify as low as ·04. It costs more to secure low phosphorus in acid than in basic steel, and this accounts for the growth of the basic output; on the whole, we think that low phosphorus should still be demanded, and care taken that cheap American rails are not foisted upon the purchaser with their customary heavy phosphorus. Campbell states that above ·08 per cent. the economy of basic steel disappears and the basic hearth loses its advantage under American conditions. Americans object also to being asked to supply rails low in silicon, their own allowance being up to 0·20 per cent., and the author here again complains that to keep silicon down will increase the cost of a first-class rail. He appears to be correct in this. Sandberg does not consider silicon to be one of the prejudicial impurities, nor does Turner or Campbell. Manganese, however, is an ingredient of more importance, and American specifications are inclined to err to liberality in this matter also. Americans demur to the demand that phosphorus and arsenic combined shall not exceed 0·06 per cent., because this is a test that can only be made when the rail is finished, and not from the ingot.

The effect of small amounts of arsenic does not appear to be prejudicial, and it seems a little strict to ask for it to count with phosphorus, from which evil impurity arsenic ought to be dissociated by the analyst. We fully agree that the demand sometimes made that each 500 tons of finished rail will be accepted or rejected on the analysis of one piece of one rail selected by the engineer and tested by an independent chemist is harsh.

This entails great additional labour, and is a senseless requirement, but when demanded in England it should certainly be demanded from the American mill. Unfortunately the average consulting engineer having accepted his quota of five guineas from all European mills for his specification, which five guineas "will not be returned," is too apt, if price or delivery does not suit him, to order from America by cable with no specification, and thereby he secures rails full of phosphorus and other things that cost money to get rid of, when to a similar open order he could have had fully as good a rail at less price from home.

(To be continued.)

POWER GENERATION: COMPARATIVE COST BY THE STEAM ENGINE, WATER TURBINE, AND GAS ENGINE.*

By JOHN B. C. KERSHAW, F.I.C.

There is no question of greater importance at the present moment to those engaged in the management of our manufacturing industries than that of Power Generation. The supremacy which the steam engine has so long enjoyed is now assailed from two sides. The water turbine and the gas engine have become dangerous rivals; and there are those who assert that early in the twentieth century, we may expect to find the steam engine ousted from its place as the most economical prime mover, by one or other of these later forms of power generator.

During the past 10 years, a most remarkable development of hydraulic power has been taking place on the continent of Europe, and in America. The large power installations in the Haute-Savoie, in France, at Rheinfelden, in Germany, and at Niagara, in America, have already become of considerable industrial importance.

The success which has attended these earlier installations of turbines and dynamos, operated by water-power, has led to the exploitation of numberless schemes of a similar character. The aggregate amount of power at the present date, generated from falling water, forms no inconsiderable portion of the total power utilised in manufacturing industries; and two years ago it was estimated by the writer to be between 236,000 and 350,000 H.P.†

On the other hand, gas engineers have been busily engaged in working out the problems presented by large gas engines, and by the utilisation of the waste gases of blast furnaces. Trials which have been made during recent years, show that both of these problems are capable of successful solution.

* Read before Section G of the British Association, September 7th, 1900.

† See *Lightning*, January 20th, 1898. Also estimate of 200,000 H.P. for United States of America, by Washington, in paper read before Franklin Institute, July, 1899.

Gas engines up to 650 H.P. have been built and have worked smoothly and economically; while at Seraing, in Belgium, and at other places, the blast furnace gases have been utilised for driving the engines which supply the blast.

The question, therefore, which the engineer now has to settle, when deciding upon the site and locality for a new factory, or when deciding upon the system of power generation to adopt for extensions of the old, is no longer so simple as when only one method of power generation in large units was open to him.

It is no doubt true that the choice between the three possible sources of power is one, which in many cases, will be settled purely by local considerations; and the proximity of a large waterfall, or of an extensive coal-field, to the factory, will be held to point to the turbine, or to the steam engine, as the most economical power generator.* In a great number of cases, however, especially when the decision of the engineer covers the choice of a site for the factory, the problem is capable of no such easy solution; and the most economical source of power can only be determined after an exhaustive study of comparative costs data. There has been an immense mass of information bearing on this subject, published in recent years, but no attempts have been made to co-ordinate these facts and data; and comparison between them in their existing form is unproductive of any useful results.

The aim of the writer in the present paper has, therefore, been to collect and arrange in comparable form some of the more important figures bearing on the cost of power generation. Full references are given to all the original articles from which these figures are drawn, and it is hoped that this summary of a large mass of scattered information may be of considerable service to all interested in the question.

I.—Steam Power.

1. Estimate by Dr. Emery of cost of E.H.P.-hour with coal at 12s. 6d. per ton, and interest charges at 5 per cent. Cost varies between ·347d. and 1·22d. being lowest with 500 H.P. triple expansion engines. This estimate is for United States of America conditions of labour.—(*Street Railway Review*, 1897, p. 391.)

2. Inquiry by Sheldon into *actual costs* of power in New England mills. The minimum and maximum costs found by the investigator were:—

(a) For 365 × 24 hours per annum, $45.69 to $261.00.
(b) For 307 × 10 hours per annum, $11.64† to $14.85.

—Abstract from "Engineering Record," Electrical Review (London), Vol. xli., page 314.)

3. Similar inquiry by H. A. Foster. The costs at the 22 plants which were examined varied between the following limits:—

For 308 × 10 hours per annum, $15.29 to $200.53 (Electrical Review (London), Vol. xli., p. 421.)

4. Estimate by Raworth of cost, using superheated steam with best types of modern engines and boilers. Schmidt or Universal engine, using 1 lb. coal (8 lbs. steam) per I.H.P.-hour and coal at 7s. per ton, taken as basis of calculation. Cost per I.H.P.-year (365 × 24 hours) = £3 14s. or ·101d. per I.H.P.-hour.—(Presidential address Northern Society Electrical Engineers, 1898.)

5. Paper by Dr. Bowman on "Power Generation." States that with a 500-H.P. compound condensing engine, the actual cost in a South Lancashire Chemical Works was £4 3s. 3d. per I.H.P.-year (2,825 hours).—(*Jour. Soc. Chem. Industry*, December, 1897.)

6. Inquiry by H. A. Mavor as to actual costs of steam power in the United Kingdom. Average of 10 factories generating in large units ·130d. per I.H.P.-hour; coal 5s. 5d. per ton. Best result of these ten obtained by a weaving mill using power generated by two 375-H.P. engines, and coal at 4s. 10d. per ton. Cost in this case only ·072d. per I.H.P.-hour.—(Paper read before Institution Engineers and Shipbuilders in Scotland, March, 1898.)

7. Details by A. Siemens, Esq., of actual cost of electrical power at Charlton Works. Cost works out to 1·287d. per KW.-hour at the switchboard of the generating plant.—(Brit. Assoc. Paper, Bristol Meeting, Electrical Review, September 16th, 1898, p. 407.)

8. Estimate by Prof. Kennedy of cost of electrical energy from steam power in Scotland, with coal at 3s. 6d. per ton. The average cost is given as £9 per E.H.P.-year.—(*Jour. Soc. Chem. Industry*, 1898, p. 314.)

9. Paper by Webber upon comparative costs of water and steam power. Gives detailed estimate of cost of latter with 1,000 H.P. plant. With coal at $3.85 per ton, cost equals $17.84 per I.H.P. year.

The best actual results known to author were with an engine running with an average load of 1,950 H.P., and coal at $2.26 per ton (d/d.). Cost worked out to $11.55 per I.H.P. per annum. These estimates are for a year of 3,070 working hours.—(*Engineering Magazine*, Vol. xv., p. 922.)

10. The actual cost of steam power in Switzerland, in the cantonal district of Zurich, lies between 224 and 635 francs per I.H.P. year.—(*Electricity* (New York), from *Le Genie Civil*, March 15th, 1899.)

11. The actual cost of power for the electric street railway in Montreal is stated by Cunningham to be slightly under ·25d. per KW.-hour.—(*Engineering*, June 16th, 1899.)

12. Estimate by Kershaw of cost of the E.H.P. hour, using best types of engines and dynamos, and coal at 7s. per ton. Cost worked out to ·141d.—(*Electrician*, December 25th, 1896.)

13. In his evidence before the House of Commons Committee on the Power Bills, Mr. Harris, of Bramwell & Harris, stated that at Liverpool the cost of power for the overhead railway had varied between ·53d. and ·31d. per unit.—(*Lightning*, July 5th, 1900.)

14. Mr. Philip Dawson, in *Engineering*, has tabulated a large number of costs data for generating stations in Europe and America. The lowest costs for generating the KW.-hour for tramway work is given in Table I. as ·1275d.—(*Engineering*, June 1st, 1900.)

In order that these estimates and actual costs may be compared, the lowest costs noted by each authority have been converted into costs per I.H.P. year of 8,760 hours, and gathered into Tables I. and II. The relationship between the cost of the I.H.P. year and of the E.H.P. year has been taken as 75:100, an energy efficiency of 85 per cent. being assumed in the combined machinery; the management, interest, and depreciation charges on the increased capital expenditure for dynamos making up the balance. The ratio of interest and depreciation charges to running charges has been taken as 40 to 100, in the two cases where these are known to have been omitted from the estimates of cost. Where the data have permitted it, allowance has been made for the fact that interest charges remain stationary, whether a 10-hour or 24-hour day is worked. The most remarkable fact about these costs, when studied in this way, is their wide variation. That the cost of steam-power should be high in Switzerland where no coalfields exist, is not surprising; but one would hardly expect to find the cost in Switzerland exceeded by that found in certain South Lancashire and Metropolitan works.

The details of two of the lowest costs, namely, Dawson's for the lowest practicable cost of generation in the United States of America, and Raworth's estimate for a South Lancashire central power station, using superheated steam, are given below, since it is of interest to have these two sets of figures brought prominently forward. The wide gap that separates these from the greater number of figures in Table I., is the measure of the improvement possible in power generation by steam:—

Table I.—Actual Costs of Steam Power per I.H.P.-year of 8,760 Hours.

Country.	Cost.	Remarks.	Ref. No.
America	£3 12 10	Compiled from lowest items in any stations.	14
United Kingdom ...	£3 14 0	Engines 375 H.P., coal 4s. 10d. per ton, weaving mill.	6
United Kingdom ...	£4 14 10	Average of 10 factories generating in large units.	6
Canada (Montreal)	£5 1 9	Generating station of electric street railroad.	11
America	£6 2 6	Engines 1,100 H.P., coal 7s. 4d. per ton, cotton mill.	2
America	£6 6 3	Engine 1,950 H.P., coal 9s. 5d. per ton.	9
United Kingdom (Liverpool)	£6 6 3	Generating station of overhead railway.	13
America	£7 19 0	Cotton mill.	3
Switzerland ...	£9 0 0	Lowest cost of steam power	10
United Kingdom (S. Lancashire)	£12 17 2	Actual cost in chemical works.	5
United Kingdom (Woolwich)	£26 5 1	Cost at switchboard in cable works.	7

Table II.—Estimated Costs of Steam-Power per I.H.P.-year of 8,760 Hours.

Authority.	Cost.	Remarks.	Ref. No.
Raworth	£3 14 0	Superheated steam. Coal 7s. per ton.	4
Kershaw	£3 18 0	Coal 7s. per ton.	12
Kennedy	£6 15 0	Coal 3s. 6d. per ton.	8
Webber	£8 17 4	Coal 16s. per ton.	9
Emery	£9 9 11	Coal 12s. 6d. per ton.	1

The reference numbers in these and the following tables refer to the details given in Sections I., II, and III. of this paper.

Dawson's estimate for the lowest practicable costs of generation, obtained by compiling a return which includes the lowest cost of each item attained in *any* generating plant in the United States of America.

	Per B.T.U.	Per KW.-year of 8,760 hours.
Fuel	·090d.	£3 5 8
Wages and salaries ...	·030d.	1 1 10
Oil, waste, stores ...	·005d.	0 3 8
Maintenance	·0025d.	0 1 10
Total ...	·1275d.	£4 13 0

—(Electrical Review, July 6th, 1900.)

* The question of freight charges, and of proximity to markets for the manufactured goods, also requires attention before a decision is taken, but this question is outside the scope of the present paper.

† (Fuel 7s 4d. per ton. Engine, 1,100 H.P.)

less than 0·10 of phosphorus, as against the 0·06 or less of European

before Franklin Institute, July, 1899.

Raworth's estimate of cost of steam power, by use of highly superheated steam in combination with suitable steam engine. (Universal or Schmidt.)

Basis.—50,000 H.P. plant. Coal at 7s. per ton. 8,760 hours per annum.

Coal, 4 tons at 7s.	£1	8	0
Margin for bad coal and starting boilers, 25 per cent.	0	7	0
Labour and management	0	10	0
Repairs and stores	0	7	6
Total operating expenses ...		£2	12 6
Interest, 5 per cent.	0	12	0
Depreciation (average on total capital, 4 per cent.)	0	9	6
Total fixed charges		1	1 6
Total cost per I.H.P.-year ...		£3	14 0

The capital outlay, including land, buildings, and 20 per cent. spare, is taken at £12 per H.P.

II.—Water Power.

1. Details of estimated expenditure upon the Rheinfelden generating station and plant. 16,000 H.P. is expected to be developed, with a capital expenditure of £225,000. This does not include dynamos.—(*Electrician*, March 26th, 1897.)

2. Estimate by Minet of cost of 1,000 E.H.P. in France. Capital outlay £24,000. Cost of E.H.P.-hour works out to ·011 franc = ·105d.—(Minet's "Electro-Metallurgie," 1898, p. 30.)

3. Details of estimated expenditure upon Massena power development scheme. Power to be developed = 75,000 H.P. Capital outlay $1,833,000. Charges to be made vary from $12 per E.H.P.-year upwards.—(Prospectus of company issued July, 1897.)

4. Details of actual charges at Niagara $19.10 to $23.50 per E.H.P.-year.—(Private letters to writer.)

5. Prof. Forbes, in a letter to the *Times*, states that the Niagara Falls Company are disposing of 34,590 H.P., and have a gross income of £150,000. This equals £4 6s. 7d. per H.P.-year.—(August 19th, 1899.)

6. Details of proposed charges to consumers of Niagara power in Buffalo. With meter and service rent, this works out to 1·4 cents. per E.H.P.-hour for small consumers, and to under 1·0 cent. per E.H.P.-hour for large consumers of power.—(*Electricity* (New York), April 10th, 1898.)

7. Statement by Wallace, that at Foyers the *operating* costs of the power station equal 30s. per E.H.P.-year —(*Jour. Soc. Chem. Industry*, April, 1898.)

8. Prof. Forbes, in a letter to the *Times* (August 19th, 1899), states that the operating expenses at Niagara for 34,590 H.P. are only £25,000 per annum. This equals 14s. 5d. per H.P.-year.

9. Detailed statement by Wallbank of cost of power development at Lachine Rapids. Present cost is $22.97 per KW.-year. This will be reduced to $8.14, when 20,000 H.P. is produced and sold.—(*Electrical World*, June 18th, 1898.)

10. Archibald states that the charges for the Lachine Rapids power in Montreal, are to small users $85, and to large users $32 per E.H.P.-year.—(*Electrical World*, August 5th, 1899.)

11. Notice of reduction of charges to $22.35 per E.H.P.-year for Niagara power in Buffalo. This applies only to large consumers.—(*Electricity* (New York), December 21st, 1898.)

12. Statement by Magee, that hydraulic power is the cheaper, so long as the capital expenditure has not exceeded £28 per E.H.P. developed.—(*Cassier's Magazine*, January, 1899.)

13. Details of capital expenditure upon a scheme of water-power development at Zurich. Total expenditure upon hydraulic and dynamo plant will be 19,000,000 francs. Total power to be developed equals 25,300 H. (gross).—(From *Le Genie Civil*, *Electricity* (New York), March 15th, 1899.)

At Zurich, according to Levin, the charge for power to *large consumers* is £6 to £7 per B.H.P.-year.—(Electrical Review, June 15th, 1900.)

14. In Norway water-power can be developed in certain districts at a cost of only 17s. 9d.—22s. 3d. per E.H.P.-year.—(*Jour. Soc. Chem. Ind.*, p. 722, 1899.)

15. At the chlorate works at Valorbes, the capital expenditure upon the development of 3,000 H.P. was £10,400, or £3·89 per H.P.—(Lunge, "Sulphuric Acid and Alkali," Vol. iii., 1896 edition.)

16. Details by Prof. Janet of actual expenditure upon water-power developments in France. This varies from £4·28 per H.P. to £30 per H.P. according to the head of water to be dealt with. The lowest expenditure was upon a fall of 140 metres in Haute-Savoie. The H.P. is calculated at the turbine shaft, and the cost of dynamos is not included in these figures.—(Electrical Review, September 30th, 1898.)

17. According to a writer in the *Electrician*, August 4th, 1899, the total inclusive charges at Rheinfelden are as follows:—

(*a*) 365 × 24 hours ... ... £6 per E.H.P.-year.
(*b*) 307 × 10 hours ... ... £5—£7 per E.H.P.-year.

18. Details by Prof. Crocker of the cost of water-power in Japan. Power is sold in Kyoto at £6 8s. per E.H.P.-year for powers up to 100 H.P., and at £3 6s. per E.H.P.-year for powers above 100 H.P.—*Electrical World* (New York), June, 1899.)

19. Details, by E. Bignami, of cost of water-power in Italy. Capital costs have averaged £12 per H.P. developed, and operating costs 56s. per E.H.P.-year.—(*Engineering Magazine*, August, 1899.)

20. Details, by B. C. Washington, of cost of water-power in California. At Mercur, Utah, the Telluride Power Company supply current over an 80-mile circuit and charge $60 per E.H.P. at the mines.—(*Jour. Franklin Institute*, September, 1899.)

21. At Meran, in the Austrian Tyrol, 2,000 H.P. is sold to the local carbide company at 47s. 6d. per E.H.P.-year.—(*Eclair. Electrique*, May 6th, 1899.)

22. In Switzerland the charges for power vary between £8 and £10 for small motors, and between £6 and £7 5s. for large motors per B.H.P.-year. In one exceptional case the charge was only $\frac{1}{11}$d. per KW.-hour.—(Electrical Review, February 2nd, 1900.)

23. The capital outlay at Lyons has been £84 per H.P. developed. Over one-half of this total had been expended upon hydraulic engineering works. At Interlaken, the capital outlay has been £34 per H.P. developed.—(J. W. Hall, in discussion upon Addenbrooke's paper upon "Electric Power Supply from Central Stations," read before South Staffordshire Iron and Steel Institute, 1898.)

Table III.—Capital outlay upon Water-power Developments.

Place.	Gross horse-power.	Capital outlay.	Outlay per horse-power.	Authority.	Reference No.
		£	£ s. d.		
Vallorbes	3,000	10,400	3 9 3	Lunge	15
Hte.-Savoie ...	8,500	36,400	4 5 7*	Janet	16
Massena	75,000	381,800	5 1 10	—	3
Hte.-Savoie ...	4,000	28,000	7 0 0*	Janet	16
Italy	Average outlay.		12 0 0	Bignami	19
Rheinfelden ...	16,000	225,000	14 1 3*	—	1
—	—	—	21 0 0	Magee's maximum limit	12
France	1,000	24,000	24 0 0	Minet	2
Hte.-Savoie ...	300	9,000	30 0 0*	Janet	19
Zurich	25,300	760,000	30 0 9	—	13
Canada (Lachine Rapids.)	6,600	—	30 0 10	Wallbank	9
Interlacken ...	?	?	34 0 0	J. W. Hall	23
Lyons	11,900	1,000,000	84 0 0	Do.	23

* This does not include cost of the dynamos.

Table IV.—Estimated, and Actual, Costs and Charges for Water-power per E.H.P.-Year of 8,760 Hours.

Country and place.	Cost or charge.	Remarks.	Ref. No.
Norway	£1 0 0	Average of actual costs at small power stations	14
Canada (Lachine Rapids)	£1 5 5	Estimated cost when 20,000 H.P. is developed	9
Scotland (Foyers)	£1 10 0	Operating costs only ...	7
Switzerland ...	£1 19 0	Lowest charge recorded ...	22
Austria (Meran) ...	£2 7 6	Charge to Carbide Co. for 2,000 H.P.	21
Norway (Sarpsfos)	£2 7 6	Average charge to carbide factories	25
United States (Massena)	£2 10 0	Lowest proposed charge ...	3
Italy	£2 16 0	Average operating costs ...	19
Sweden	13s. to £3	Estimates by Carlsen ...	24
Japan (Kyoto) ...	£3 6 0	Charge to large users ...	18
Canada (Lachine Rapids)	£3 11 9	Present cost of power ...	9
France	£3 16 7	General estimate of cost ...	2
United States (Niagara)	£3 19 7	Charge to large consumers	4
United States (Niagara)	£4 6 7	Average charge for whole of power	5
United States (Niagara)	£4 13 1	Charge for Niagara power in Buffalo	11
Switzerland (Schaffhausen)	£4 5 0	... ...	26
Switzerland (Zurich)	£5 10 6	Charge to large consumers	13
Germany (Rheinfelden)	£6 0 0	Charge to large consumers	17
Japan (Kyoto) ...	£6 8 0	Charge to small consumers	18
Canada (Montreal)	£6 13 2	Charge to large consumers	10
United States (Utah)	£12 10 0	Charge over an 80-miles transmission line	20
Canada (Montreal)	£17 14 0	Charge to small consumers	10
United States (Buffalo)	£25 11 0	Charge for Niagara power to small consumers in Buffalo	6

24. According to B. Carlsen, water-power in Sweden costs between 13 and 60 m. per E.H.P.-year.—(*Zeits. f. Elektro-chemie*, vi., p. 471.)

25. At Sarpsfos, in Norway, power is being sold by the Power Company to the two carbide works at 45—50 m. per E.H.P.-year.—(*Chem. Industrie*, April 1st, 1900.)

26. Statement that lowest *charge* for water-power in Switzerland is £5 per B.H.P.-year at Schaffhausen.—(Electrical Review, June 15th, 1900.)

In the following two Tables (III. and IV.) these estimates and actual costs have been reduced to comparable form. The relation between the B.H.P. and the E.H.P. has been taken as 85 : 100. One is again struck by the wide variation of the figures. The capital outlay per H.P. ranges between £3 9s. 3d. at Vallorbes and £84 at Lyons. The estimated, and actual, charges per E.H.P.-year show the still greater difference between £1 at a small unnamed power station in Norway and £25 11s., the charge to small consumers in Buffalo.

The figures given by Wallbank for the cost of power at the Lachine Rapids Station in Canada, and by Janet for the capital outlay upon typical water-power development schemes in France, are sufficiently interesting to deserve further consideration, and they are reproduced below.

Details of capital expenditure and running expenses, at Lachine Rapids Power Station, from Wallbank's paper, before National Electric Lighting Association, Chicago, 1898 :—

Power at present developed is 4,000 KW.
Power available is 15,000 KW.

Allowing for 10 per cent. losses between turbines and dynamos, the capital expenditure has been $263.83 per KW.

The annual costs per KW. at present are :—

Interest at 6 per cent.	$15.95
Depreciation at 5 per cent. (on one-third of capital outlay)...	4.17
Operating expenses	2.85
Total	$22.97

$22.97 per KW.-year = £3 11s. 9d. per E.H.P.-year.

The annual costs per KW. when 15,000 KW. is generated will be

Interest at 6 per cent.	$4.95
Depreciation at 5 per cent. (on one-third of capital outlay)	1.68
Operating expenses	1.51
Total	$8.14

$8.14 per KW. year = £1 5s. 5d. per E.H.P.-year.—*(Electrical World*, June 18th, 1898.)

Details of Three Water-power Development Schemes in France.

1. 6,000—11,000 H.P. (mean 8,500 H.P.) in Upper Savoy. Fall 140 metres. Capital outlay £36,400 = £4 5s. 7d. per H.P. at Turbine Shaft.

2. 4,000 H.P. in Department Isére. Fall 100 metres. Capital outlay £28,000 = £7 per H.P. at Turbine Shaft.

3. 300 H.P. in Upper Savoy. Fall 2 metres. Capital outlay £9,000 = £30 per H.P. at Turbine Shaft.—(Electrical Review, September 30th, 1898.)

These figures illustrate well the effect of height of fall upon capital outlay, and show the great economy of utilising or creating high falls of water for industrial purposes.

The difference in capital outlay between examples 1 and 3 represents an *addition* of £1 6s. per H.P. per annum to the cost of power at the latter power station, *in interest charges alone*, and more than this if depreciation be taken into account.

The figures showing the increase of charge due to transmission are also of striking interest. Niagara power at Buffalo costs £4 13s. 1d. per E.H.P.-year as compared with £3 19s. 7d. at Niagara. The power from Lachine Rapids costs £6 13s. 2d. per E.H.P.-year in Montreal, whereas the present costs at the generating station are only £3 11s. 9d.

In Utah the charge to mines on an 80-mile transmission line is £12 10s. per E.H.P.-year; the cost of generating this power at Provo is probably not one-fourth of this amount.

These figures are worthy of close scrutiny by those interested in the power schemes which have lately been occupying the attention of our legislators, since they indicate that transmission costs and losses, are capable of doubling or trebling the costs of electricity to the consumer.

(To be concluded.)

GAS ENGINE FUELS.

Prof. Kerr states, in an article in *Cassier's*, that natural gas has a calorific capacity of 1,000 thermal units per cubic foot. Yet it has been sold as low as 5d. per 1,000 feet, and in gas engines has given 1 B.H.P. with a consumption of 9 feet per hour and a heat efficiency of 28 per cent. For mill use the gas at Pittsburg was sold as low as 2½d. per 1,000 feet, so that a gas engine, allowing 10 feet per H.P.-hour, would use only one farthing's worth of gas per day of 10 hours, the annual cost of a B.H.P. being about 6s. for 3,000 hours. Natural gas is found to be stored by nature at a pressure of 320 lbs. per square inch in the Indiana field, and 450 lbs. in Ohio, with a maximum of 1,020 lbs. at Castle Shannon, in Pennsylvania; but pumps are now required to actually draw gas from the depleted wells, and gas is sent into Chicago compressed to 300 lbs. by artificial means; it reaches Chicago reduced to 2 or 3 inches of water only, the pressure having all gone in pipe friction.

In the old days the gas was used in its natural state to work engines by its pressure, not by its explosion. It has been shown that more light can be obtained electrically from gas burned in gas engines than by its combustion direct as a lighting agent, and the author states that if gas companies would use gas to generate electricity, they would be able to distribute as much light as they now do, and still have 60 per cent. of their product for sale.

Illuminating gas, however, will not pay when used for power purposes. At 2s. 3d. per 1,000 feet, and 20 feet per B.H.P.-hour, it will cost £6 per H.P.-year for fuel only. Coal at 8s. per ton, when used at the rate of 3 lbs. per H.P.-hour, only costs 36s. per annum, and, moreover, the gas engine will cost more than the steam engine. Only small plants can afford gas, because the boiler is saved, and the attendance is reduced very largely. For large powers producer gas must be employed, or the waste gas of blast furnaces. The latter has about 30 to 33 per cent. of combustible, and, in fact, is very like producer gas. Prof. Spangler reported in 1893 that the fuel cost of a plant of 100 H.P. was only 1·3 lb. per B.H.P., and the mechanical efficiency was only 72 per cent., proving the capacity of the gas. The author does not appear to be acquainted with gas production from bituminous fuels, so that his views of the utility of producer gas are bounded by limitations that have no real existence. He evidently thinks that producer gas must be made from coke or anthracite, whereas bituminous fuel can be used in the duplex system.

In using gas fuel its efficiency increases with its initial compression. Thus compressions to 38, 66·6, 82·5, and 95 lbs. gauge pressure gave efficiencies of 17, 21, 25, and 30 per cent. With constant mixture, now no longer employed with poor gases, a limit is set to the compression, for with successive pressures of 24, 61, 105 and 112 lbs., the explosion pressures were 27, 117, 233 and 347 lbs., the explosive pressure increasing faster than the compression, probably, we may add, because of the more perfect combustion. The author appears favourable to the Diesel motor in which the fuel is burned at constant pressure, but he admits that the principle has not yet been successfully applied except with oil, it having so far failed with gas.

With small gasoline motors, 10 lights of 16 C.P. each can be produced for ½d. per hour each. This is rather more than the price charged by city central plants. Prof. Kerr looks on the small gas or gasoline engine as the ideal power for lighting small factories, schools, and residences. The cheapest lighting agent would, no doubt, be producer gas burned with an incandescent mantle, but the deadly nature of producer gas puts it out of competition when burned in a room, and it could only be used with safety by means of special contrivances entirely shutting off the flame from the house, as in a special glazed and ventilated cavity.

HEAVY MOTOR VEHICLES FOR ROAD SERVICE.

Various types of heavy motor vehicles are illustrated and described in the *Engineering Magazine* by Mr. F. W. Maynard. They are just such as may be seen any day in the streets of London. Undoubtedly heavy, apparently easy to manage and steer, and well up to their duties; they are, however, dangerous to foot passengers, owing to the lack of even the simplest guarding to the forewheels, which stand out aggressively in front of the vehicles. This fault is as inhuman as it is unnecessary, and no excuse can be offered for its existence. The present series of motor vehicles includes amongst others, drays 16 to 18 feet in length, with an area for load of 56 to 70 square feet. The extreme width—a legal limit—is 6½ feet. The frames are of channel steel, and the wheels are either of military type with oak spokes and metal hubs and felloes, or all metal, which, however, is not recommended, a wooden spoke being conducive to durability.

The Thorneycroft steam wagon has a wheel base of 9 feet 11 inches, and the tires are 5 feet 6½ inches apart centre to centre. The platform has an area of 68 square feet, and stands 3 feet 11 inches high unloaded. It sinks to 3 feet 9½ inches with 3 tons of load. Ordinary laminated springs are employed, and the driving axle is a piece of forged steel shaft, stated to be as large as a shaft capable of transmitting 120 H.P. at 120 revolutions per minute, though only required to transmit 35 H.P. as a maximum, the excess being a concession to reversed stresses and shock.

The front wheels measure 34 inches × 4⅜ inches, the driving wheels 39 inches × 5¼ inches. The boiler is of water-tube type, fired centrally from the top, the fire being completely surrounded by the tubes connecting the top and bottom annulus, the lower of which actually contains the fuel. The boiler has a heating surface of 83 feet, and a grate surface of 2·4 feet; the working pressure is 115 lbs. and the test pressure 350 lbs. Of the two safety valves one is set 10 lbs. above the other, and blows in full view of the driver. Feed is by a pump driven by worm gear off the engine shaft, with a return of the excess by hand regulation to the tank. There is also a self-starter injector, of which the cones can be withdrawn with the boiler under steam. The engine is compound horizontal reversing, with cylinders 4 inches and 7 inches × 5 inches stroke, enclosed dust-proof in an oil splash chamber, and equal to 20 B.H.P. at 440 revolutions per minute, but capable of running up to 770 revolutions per minute and doing 35 B.H.P. It measures 3¼ feet × 2½ feet × 1½ feet, and weighs

5 cwt., and it can be run independently of the vehicle. The exhaust first performs duty as a feed heater, then escapes through a silencer to the blast nozzle, and passes, superheated and invisible, into the atmosphere.

Power is transmitted by machine-cut wheels through a countershaft and universal joints to take up all spring and bump motion. The gearing ratio is 10·1 : 1 and 18·7 : 1. On ordinary grades 5 to 6 tons of load can be taken, and a load of 3½ tons has been carried up a gradient of 1 in 6 with the slow speed gear. There are brakes on the drivers, water tanks of 160 gallons capacity, sufficient for 15 to 20 miles, and fuel bunker for 5¾ cwt., or enough for 50 miles, but there are no guards to the very dangerous front wheels. Other vehicles do not differ much in general dimensions. A brewer's dray by Coulthard & Co. works at 225 lbs. pressure with kerosene fuel, and triple engines of vertical type, with cylinders 2¾ inches and 4⅛ inches and 6 inches by 5 inches stroke, developing 14 B.H.P. at 500 revolutions per minute, with graphite lubrication, a tubular condenser of Row indented tubes and a final drive by Renold chains, the total ratios of gear being 7, 11½ and 19½ to 1 forward and 27·4 to 1 in back gear; 84 gallons of water and 22 of oil may be carried.

The Clarkson and Capel Steam Car Syndicate also do not lubricate the cylinders, nor is it even said that they use graphite.

Simpson and Beaman, of Manchester, use a boiler of the flash type, with Row's indented tube, and remind us that the flash type of boiler is referred to by Dr. Lardner, a copy of whose book published in 1836 is before us—the first edition having appeared in 1827. This was Howard's patent. Howard placed a vessel of mercury over a coke fire. The mercury carried an iron plate, and at each stroke of the engine water was injected upon the plate and converted to superheated steam. Thus, says Lardner, steam at 25 lbs. pressure may have a temperature of 400°. In the same old book we find a description of Hancock's and Gurney's steam road cars and their boilers.

The description of Gurney's car might be that of Thorneycroft's, including steam blast and silencing chamber, and Lardner talks familiarly of pressures of 400 to 500 lbs., and of speeds of 9 miles per hour. Hancock's carriage weighed 3½ tons and carried 14 passengers. Hancock also used chain gearing. With this book of Lardner's and the materials of to-day we ought to make successful motor vehicles if they could do it in Hancock's and Gurney's time 80 years ago. Gurney cleaned his tubes with acid, as is done to-day with the Serpollet boiler, until he found that he could not get it performed well by the common workmen, when he provided plug-holes and used scrapers, but Dr. Wollaston wanted him to stick to the acid. Gurney's water-tube boiler, by the way, is a better design by far than the Belleville. It is added that Gurney's carriage ran up all the hills between London and Barnet and Stanmore, mounted Stanmore Hill and Brockley Hill, and even Old Highgate Hill, of which part is 1 in 9. The makers of the motor vans of to-day have very faithfully copied Gurney in all points, even to neglecting lifeguards, and had it not been for the local authorities of that day, the country would have been full of motor vehicles this last 50 years.

THE ELECTRICAL EQUIPMENT OF THE TALL OFFICE BUILDING.

In this month's issue of the *Engineering Magazine* there appears an article under the above title by Mr. Reginald Pelham Bolton, which is of considerable interest owing to the novel conditions attaching to the supply of electrical energy to these 28 and 30-storied buildings which for some years past have been making their appearance in the main thoroughfares of New York, Chicago, and other important business centres throughout the United States.

These buildings often contain as many as 1,500 offices, each of which will require one or more lights, the total number of lamps installed being brought up to about 4,000 with passage and other lamps.

The Bowling Green block of offices, of which Mr. Bolton makes special mention, is well known to the writer, and is perhaps the largest of this type of building that has been erected in New York. It is possible that the "Rookery," in Chicago, may contain a larger number of offices, but upon this point the writer is not quite sure.

The Bowling Green building is wired for 3,200 points. Its inhabitable area is 247,000 square feet. Its cubic contents 4,915,000 cubic feet, and the number of lamps installed is 6,300. These figures will give some idea of the immense proportions of this building.

The question of lighting the building does not in itself present any difficulty, or even any points of novelty or interest beyond the magnitude of the operations involved. But when one considers that many provincial central stations have been erected whose hopes of success were based upon having to supply current to 5,000 lamps within a reasonable period, and when one reflects upon the many articles, papers, and pamphlets which of recent years have been written upon the limiting number of lamps in any one installation at which it ceases to be economical to obtain current from the supply company, the idea naturally suggests itself that these huge private installations may become formidable competitors to the public supply companies. Indeed, there is no impossible element in the suggestion that these large private installations might with advantage both to themselves and to the supply companies, sell current to the supply company during the evening hours or at any other time when the demand for the building itself was small.

There can, of course, be no doubt at all that for so large a number of lamps as 5,000 installed in one compact building, current can be generated from a private plant more economically than the supply company can afford to sell it.

Mr. Bolton asserts that he has examined the figures of a number of office buildings, and in all of them the cost of electrical generation is very much lower than the lowest rate of outside supply, and he concludes that "until current can be supplied to such buildings during the hour of maximum load at less than 2 cents for KW.-hour, it will not enter into competition with the internally generated supply."

Mr. Bolton's argument in support of this conclusion is briefly to this effect:—

In almost every instance a private plant is of the non-condensing order, and the exhaust steam is used when required for heating, supplemented, of course, by heat from the boilers or a special boiler when necessary. The maximum amount that the office building could afford to pay an outside company for its light, heat and power for lifts would be a sum equal to the coal bill plus interest, depreciation and repairs on the entire plant, together with all of the wages account, except, say, that of the engineer and an assistant.

Mr. Bolton finds that for such a building as the one first mentioned the gross cost of working the lifts, supplying light and heat, and pumping for a year, including interest and depreciation, will come to about £2,192. Now, in order to compete with the office building plant, the supply company must be able to provide for a sum not exceeding £2,192, 135,000 KW.-hours for lift service; 181,000 KW.-hours for lighting, and 4,200,000,000 British Th.U. for heating.

Putting the wages of one engineer and assistant as above at £300 per annum, the price charged by the supply company for the above must not exceed 1d. per KW.-hour, for the energy used by the lifts, 1½d. per KW.-hour for lighting, and 17d. per million British Th. U. units for heating.

We cannot criticise this argument in detail, as Mr. Bolton does not state how the original figure of £2,192 per annum is arrived at, but as he tells us that he has had an opportunity of examining the costs of production of electrical energy in many cases of office building plants, we may assume that the above figure is derived from a comparison of the costs of similar plants. On broad principles we have little hesitation in endorsing Mr. Bolton's argument, but having regard to the very peculiar character of the lighting load of a block of offices it would be almost impossible—in the absence of figures—to calculate the actual cost at which the office building would find it of advantage to take a supply from the public company.

Mr. Bolton states that the lighting load consists of a very light day load with a sudden, but short, evening load, averaging 70 per cent. of the maximum, and with infrequent but abrupt maximum loads during day darkness, such as those preceding thunderstorms, and still more rare days of fog. This is, of course, precisely what one would anticipate, but the duration of the 70 per cent maximum load must be exceedingly short in summer, and as there is nothing to compensate for this at other times of the day, the lighting load curve for a summer's day at the Bowling Green offices must be of a shape that would turn a central station engineer's hair grey in very short time. In this country, where 5 p.m. is the ruling hour at which work ceases at offices no light at all would be required except for dark passages. In America, business men stay much later at their offices, and thus the demand for light would be somewhat greater. Further, in New York the architect is not hampered by light and air restrictions, and it is not an uncommon thing for the windows at one side of a "sky scraper" to be subsequently blocked by another building going up alongside. In these circumstances it is conceivable that many rooms in a building like the Bowling Green offices may sooner or later be wholly dependent upon artificial light, which again would raise the demand in the summer months. Then, of course, the complete and extensive service of lifts makes a demand for energy upon the plant, but, unfortunately, the demand made by this is of such a character that if it is supplied direct the engineer of a private plant would really rather be without it as far as helping him to produce economically is concerned.

Mr. Bolton is no friend of the application of electricity to elevators. He even goes so far as to suggest that under no circumstances can an elevator service be operated direct by electricity in a "sky scraper" as economically as by hydraulic power. His views may be summed up as follows:—

Without an electric storage battery the high-speed electric elevator is not so economical as the hydraulic elevator, nor can it be combined satisfactorily with electric lighting work.

The additional cost of a battery with interest and depreciation outweighs, in his opinion, any gain in economy.

An electric lift costs more for labour, maintenance and repair than an hydraulic one.

Mr. Bolton is of opinion that the high speed elevators which are an essential element in a building 28 stories high, are radically unsuited for operation by electricity. Without a more detailed statement of the facts upon which Mr. Bolton bases this view, we are not in a position to contradict his assertion with reference to any special case which he may have in his mind, but we certainly think that so sweeping a statement is unwarranted on general principles. Having regard to the character of the lighting load of such buildings it would appear that the introduction of a hydraulic accumulator of suitable size operated by a motor would be

a useful way of improving the load factor, but possibly this is what Mr. Bolton means to imply, though he does not actually say so.

An interesting suggestion is made as to the utilisation of the plant which, for so many hours during the day, is running at practically no load. In the case of the Bowling Green building the light is supplied from a large storage battery, which is charged during hours of light load from a neighbouring central station. This battery feeds its district at the same time, and helps to maintain the proper pressure by discharging in parallel with the station during hours of heavy load.

Mr. Bolton proceeds to give figures relating to an installation capable of supplying current for 4,000 lamps installed in a building such as the Bowling Green building, and deduce from these figures that without making any allowance for the use of exhaust steam for heating the building, the cost would work out to a little over 1d. per KW.-hour generated. He concludes with the view that if electric supply companies were to combine heating by steam with the supply of energy, they would be placed in a much more favourable position for competing with the private installation. He does not give any figures in support of this view, which, of course, does not apply to English conditions of office life, and we very much doubt, from our experience, whether it would apply to American office life to the extent anticipated by Mr. Bolton.

CORRESPONDENCE.

Prof. Thompson's Lecture at Bradford.

My attention has been called to the last paragraph of your editorial article of September 21st, which contains (besides several personalities that I pass in silence) several allegations or insinuations that I cannot pass. I therefore invite you kindly to say whether or not you intend your readers to understand the following things to be asserted:—

1. That I showed amongst the slides at my Bradford lecture on electricity in the industries none of electric traction with overhead wires.

2. That I advocated running tramcars through to all the other towns in Yorkshire without any overhead wires.

3. That I made no mention of any other way of dispensing with overhead wires than my own (Thompson-Walker system).

If this is what you mean, will you kindly say so plainly.

Silvanus P. Thompson.

[We did not say that no other alternative method was mentioned; what we did say was, that no other system of surface contact traction was shown or referred to. We do not say that the lecturer should not have brought forward the Thompson-Walker system, but honour was also due to others "who had laboured in their day in the surface contact field." The overhead trolley system was certainly "not much in evidence" among the lantern pictures, as we said last week. The Professor's remarks led us to believe that he considered overhead wires unnecessary. With the above exceptions we congratulated the lecturer upon his admirable discourse.—Eds. Elec. Rev.]

POWER TRANSMISSION BY SHAFTING v. ELECTRICITY.

A very interesting report, evidently written by engineers thoroughly conversant with power distribution in factories, has been prepared on this subject by a Committee of the Master Mechanics' Association of America for the benefit of the Association.

A report of this description dealing with American practice is interesting to works managers in this country, especially at the present time when motors are being installed in large quantities for power driving in our factories and works.

Motors are used in the States for power work to a very much greater extent than they are in this country, and consequently there is a good deal to be learnt from the different methods and systems which have at one time or another been adopted in American workshops for tool driving.

The Committee have made a point of analysing the different systems they have come across and of emphasising the strong features, whilst commenting on those which they have not considered desirable.

In the following article we have picked out some of the best points of the report, and in some cases criticised and compared them with our own experience in this country.

The report divides the subject of power distribution into three headings:—

(*a*) Relative economy in cost of power itself.
(*b*) Relative convenience of operation and installation.
(*c*) Relative effect upon shop output and cost of labour.

Economy.—In order to compare the relative efficiencies of steam and electric transmission, and arrive at the cost of operating the two systems, by taking into account the expense for fuel, attendance, repairs, interest on investment and depreciation in each case, the character of the shop plant is divided under two heads:—

1. Shop plant, in which each building has its own power plant.

2. Shop plant, in which all buildings are furnished with power from a central source.

The manner of connection from the prime mover to the tools, is assumed, for comparison, in either of two ways, namely, the shafting method, and the individual tool-driving method. The shafting method involves the grouping of the tools on suitable lengths of shafting, which are motor-driven. On the other hand, the individual tool-driving method implies the use of separate motors for tools requiring over 3 H.P. each.

Taking the case where each building has its own power plant, the average efficiency from engine to tools for steam engine transmission is shown to be approximately 50 per cent., whilst for electric transmission with the shafting method, the efficiency comes out at about 52 per cent.

With the electrical individual tool-driving method, however, the efficiency comes out at about 60 per cent., showing a small gain for this method.

Next, taking the case in which all the buildings are furnished with power from a central source, it is pointed out that some small saving will be made in the power required for each individual machine, and further, a considerable saving due to the better efficiency of a large engine and boiler plant over that of several smaller ones.

In extreme cases where large condensing engines replace small non-condensing ones, and in large stations having a uniform load, the fuel saving may readily be 33⅓ per cent. From these figures it will be gathered that only in the latter case can large savings be expected in the fuel bill. The latter case represents, however, the system which is usually adopted for electrical power distribution in factories, namely, generating at one centre and distributing from that centre.

The Committee have come to the conclusion that the *attendance* necessary on an electrical transmission plant will cost as much per annum as on a steam engine plant. It is supposed that what the electrical system saves in keeping in order a reduced number of engines, boilers, bearings and belting, it loses in the additional cost of the electrical attendance. In our opinion there are a great many cases where the attendance can be considerably reduced for the electrical systems, and, in fact, it is not difficult to find cases where they actually have been reduced.

It is certainly false economy to cut down the electrical staff, as motors, if kept clean and well looked after, will last much longer and save in repairs, but a staff of intelligent youths or trained labourers will keep a set of motors in first-rate condition under a capable electrician, whilst a set of small steam engines will require a more experienced and better paid staff.

The motor, with its rotary motion, requires less attention than the engine with its reciprocating motion, and a set of steam engines, unless kept in first-rate condition, will require more expensive repairs than a plant of motors to do the same work.

The experience of large motor users in this country has undoubtedly been that, by substituting motors for steam

engines, the necessary attendance has also been materially reduced.

With regard to *repairs to plant*, the report goes on to say that the cost of the one system about equals that of the other.

Here, again, it is difficult to understand this statement. There is little question that the repairs necessary to motors and generating plant are a good deal less than is the case where independent steam engines are in use.

This fact will perhaps not show itself very forcibly during the first few years of working, but after a plant has been running for, say, five years, the steam engines will require greater annual repairs than the motors.

It is more than probable that the American system of installing motors may have a good deal to do in raising the cost of maintenance.

It is well known that American motors are rated a good deal higher than those of British manufacture, and American motors installed in this country have been found to be expensive in maintenance, and not to last as long as those made in Great Britain, due largely to this cause.

Makers of motors in this country have appreciated the fact that a machine which is rated low will stand better than one in which the margin is a small one only, and the low maintenance costs obtained in many works in this country are largely responsible for this fact.

British practice in this respect has been to put down plant which will last for years without maintenance or repairs; on the other hand, a very much shorter period will satisfy American practice. Consequently, although the report may be correct in stating that the maintenance of a motor plant will cost as much as a steam-engine plant, when applied to American practice, it certainly does not apply to a plant which contains motors installed with sufficient margin.

The last item of power cost is *interest and depreciation*. The report rightly shows that thanks to certain advantages and facilities gained by adopting electrical power distribution, the total first cost of the electrical plant cannot with justice be compared with the total first cost of a similar shafting distribution system which is not possessed of those advantages.

It states, however, that the electrical driving system will cost about double that of an ordinary shafting system. A sum representing 10 per cent. per annum on the capital invested is usually allowed for the two items of interest and depreciation, and this item amounts to about one quarter of the total running cost of the plant per annum.

Under the heading "Convenience and Shop Output" some very practical remarks are made, remarks on points which are often lost sight of in laying out new works.

It is pointed out that with steam power transmission the arrangement of the buildings and of machines is laid out so that the shafting and engine connection is as direct and simple as possible, with the result that the machines must be compactly arranged in parallel lines, and the ceiling and columns designed specially for shafting support.

In other words, the tools must be installed with first reference to the application of power, and not, as should be the case for most economical working, with first reference to handling the work to the best advantage.

Electrical transmission places no restriction on the location of the machines, and each shop may be planned with a view to handling its product with the least waste of labour, and with the greatest convenience of access to tools.

It is to be regretted that this fact is often lost sight of in planning new shops and in arranging the tools in them, and although electric motors are now usually introduced for driving some of the lengths of shafting and isolated tools, this is done more with a view to cutting down some of the running losses than to enable the tools to be arranged in the most suitable and favourable positions.

These points, combined with partial or entire absence of overhead line shafting, ensure better lighting of the shops, and conduce to cleanliness and increased output.

Under the heading of "Special Appliances," it is pointed out that electricity shares a large field with compressed air, but as the latter has received more attention than the former, it is somewhat ahead of electricity for special appliances, such as small hoists, chipping tools, &c.

It appears to us very doubtful whether electricity will ever compete with compressed air for some of these applications. No new shop or foundry is complete without its compressed air plant for driving these special tools, which are both convenient and cheap in use.

There are many applications to which electricity is better adapted, but to others it cannot be applied to the best advantage.

As regards *flexibility*, it is pointed out that extensions with a shafting system are difficult to carry out without inconvenient crowding of the tools or without overloading or complication of the shafting system.

On the other hand, the electric system is flexible, and new buildings may be placed in any convenient position and additions made to the driving system without affecting the intermediate links.

In the opinion of the Committee, *increase in output* constitutes the chief claim of electric transmission to the attention of shop managers.

The saving in time introduced by using electric handling devices, whereby the tool is quickly served with its work, and the idle time therefore cut down, and by independent driving whereby the capacity is increased by reason of the perfect speed control, are the two chief factors tending to increase the output.

Some points are raised in the report with regard to continuous and alternating current motors for shop use.

The simplicity of the alternating motor is mentioned, whilst the disadvantages of its running at so high a speed and of its being essentially a constant speed motor, are touched on. It is pointed out that for driving line shafting these are not points of great disadvantage.

It should, however, be remembered that, although shops often start by replacing steam engines by motors for driving the line shafting, an application easily carried out by an alternating motor, yet eventually extensions to the electrical system will require the motors to be direct connected to tools requiring speed control and often heavy starting torques, which will necessitate either a continuous current supply being laid on in addition, or full advantage not being taken of the possibilities of electrical driving.

In shop installations, where polyphase motors are used for power purposes, it has been necessary, in some cases, to lay down a further continuous current supply for the arc lamps, and for motors, such as those on the cranes, necessitating heavy starting torques. This mixing of the systems cannot be recommended, and therefore, in choosing the system, the ultimate and not the present requirements should be studied.

Under the heading of "Motors," it is advocated that these should be of the open type when used for driving tools or shafting, and, in fact, whenever possible, due to their running so much cooler. On the other hand, for travelling cranes, hoists, transfer tables, locomotive turn-tables, and boiler shop plate rolls, all of which loads are intermittent, motors of the enclosed type are recommended on account of their fitting into the gearing better than those of the open type. The temperature question does not come into consideration here, due to the intermittent nature of the load.

It is very interesting that this should be the opinion of a Committee of American engineers reporting on American practice, as the enclosed type of motor has been very extensively used in America, and has, in fact, been imported into this country from there, and is recommended for adoption in most cases by consulting engineers in this country, largely on the strength of its reported success in the States.

In these pages we have repeatedly pointed out the disadvantages of this type of motor, yet the fashion has been set by engineers, and not until users themselves began to find out the disadvantages did the installation of this type of motor on a wholesale scale begin to diminish. Most practical engineers have, however, now found out from experience that the type of motor must depend upon its position and the work it has to do.

In many cases, however, where a motor must be enclosed, it will be better to use one of the open type and enclose it in an iron-lined wooden box, than to use one of the ironclad type. The wooden box can be removed at any time for inspection purposes.

Manner of Tool Driving.—The report recommends that tools requiring less than 3 H.P. each should be grouped

together on short line shafts, whilst each motor for driving such a group should be of about 25 H.P. size.

Both these sizes correspond very closely with good practice in this country, though often the group motor is 20 H.P. instead of 25 H.P.

For individual driving, either belted or geared motors are employed.

The report states that the belted arrangement is somewhat clumsy, but reduces shock and prolongs the life of the motor, and is, in the opinion of the Committee, the better arrangement for general use. This is, in our opinion, extremely sound advice, and certainly the experience of the largest motor users in this country.

It is interesting, as coming from America, where the practice has hitherto been to gear the motors as far as possible, in order to make a more compact job. We understand, however, that direct gearing is now being largely given up in favour of belt driving.

The conclusions the Committee have come to are as follows :—

1. In a small shop consisting of practically one building, having an equipment of small tools for light work only, electric transmission will not be found a paying investment. In such a shop, however, an electric lighting dynamo will be a convenience, and may be utilised to run a few labour-saving electric tools, such as a cylinder boring outfit, a turntable motor, &c.

2. In an extensive railway shop plant the installation of a central power station and electric transmission will always be found advisable, as it will not only result in the most economical system in respect to operation, but will make possible far more important shop economies, namely, an increase in quantity and quality of output, and a reduction in the cost of handling.

PRACTICAL CONSIDERATIONS INVOLVED IN THE GENERATION OF POWER BY BLAST FURNACE GAS.

The growing importance of the blast furnace as a source of cheap power has led us to give the following particulars of its working and of the results obtained in practice.

The average output of pig-iron per furnace per week in Great Britain is about 450 tons. The average weight of coke consumed is equal to the weight of pig-iron produced. Reducing this to the weight of coke consumed per hour, gives 2·678 tons per furnace.

In the blast-furnace each ton of coke charged requires for its combustion 4·47 tons of air blast, which measured at 60° F. and 30″ Bar. = about 131,747 cubic feet.

A rather complicated calculation would show that for each ton of coke consumed in the blast furnace there is evolved a volume of gas, which if reduced to 60° F., at atmospheric pressure would measure about 170,000 cubic feet; 2·678 × 170,000 cubic feet = 455,260 cubic feet of gas evolved per hour per furnace.

Where coal is employed as fuel in the blast furnace, the gases have a higher thermal value owing to the presence of volatile hydro-carbons, and tar is deposited in the tubes and flues, but the volume of gas given off per ton of coal charged is only about 130,000 cubic feet, when measured at 60° F. and 30″ Bar.

Some furnaces use as fuel a mixture of coal with coke, in which case the gas given off per ton of fuel charged is proportionally somewhere between 130,000 and 170,000 cubic feet.

This gas, as it escapes from the top of the materials constituting the charge in the furnace, has a high physical temperature ranging between 300° F. and 700° F. according to the depth to which the stock in the furnace has been allowed to descend; we may consider the average temperature to be 500° F.

The gas carries with it water in the form of vapour, and solid particles of dust.

The proportion of aqueous vapour carried by the gases will depend upon certain conditions :—

1. Whether the ore is calcined, or charged while containing a considerable percentage of moisture.

2. The percentage of moisture contained in the fuel.

3. The method adopted for recovering the gases at the top of the furnace.

The average of six determinations, at a furnace using French and Spanish ores, with coke and limestone, gave 2·3 per cent. of water vapour.

Where the ore is calcined and charged in a dry state, and when open-tops are in use at the furnaces, allowing a portion of the gases to ignite at the top and drying the raw materials being charged into the furnace, the gas drawn off will not contain a high proportion of moisture due to the ore and coke; but where the bell and hopper method of closing the top of the furnace is adopted, and the charge consists of ore and coke that has been subjected to the ordinary conditions of the atmosphere, or charged in a hydrated condition, the proportion of moisture may reach 10 per cent. and above.

Having 1 lb. of water in the form of moisture in the gases issuing from the blast furnace, in the proportion of 10 per cent. by weight, if the gases are cooled down to 32° F., the 1 lb. of vapour will be condensed, and at the same time will liberate 1,146 B.Th.U. A cubic foot of b.f. gas at 32° would weigh about ·08 lb., so that 10 lbs. of gas = 125 cubic feet, which at a calorific value of 100 B.Th.U. per cubic foot = 12,500 B.Th.U. If the gas with its moisture at a temperature of 32° F. were admitted into the cylinder of a gas engine, about 9 per cent. of the heat value of the gas would be absorbed in evaporating this amount of water.

The dust carried by the gases consists of fine particles of ore and coke, and also a fine fume liberated during the operation of smelting the ore, and fluxing the earthy matter.

The quantity, or weight, of dust carried by the gases diminishes with the distance from the furnace, the heavier particles being deposited in the tubing in close proximity to the furnace, while the lighter portions are carried to very considerable distances, though there is an accumulation of dust deposited in all the passages through which the gas travels, unless special provision is made for arresting it.

The quantity of dust is dependent to some extent upon the class of ore used, but still more on the quality of metal produced, as when furnaces are producing ferro-manganese, spiegeleisen and basic pig, the dust is in much higher proportion than when ordinary qualities of pig-iron are required.

Even when the gases have been ignited in stoves and boiler furnaces, light dust is carried along and escapes from the tall chimneys.

Determinations of the weight of dust carried by the gases can be roughly made by weighing the dust removed from the flues and tubes when the periodical cleaning has been performed.

Mr. A. S. Keith, of Middlesborough, has stated that the quantity of dust per week from a furnace, making from 600 to 700 tons per week (Cleveland ore), amounted to from 2 to 5 tons per week, though in another case only about 1 ton per week of dust was obtained.

M. A. Greiner gives the quantity of flue dust at the Seraing furnaces as follows :—

From two furnaces which together produce 300 tons of pig-iron, there are produced 13½ tons of heavy dust daily, or 10 grammes per cubic metre, corresponding to 0·81 per cent. by weight of the gases. Of the light dust 3 tons daily are produced, or 2·2 grammes per cubic metre, equal to 0·17 per cent. by weight.

The heavy dust consists chiefly of purple ore particles. The furnace charge is composed of 20 per cent of pyrites residues, along with 80 per cent of Bilbao ore.

Another determination gives 5 grammes per cubic metre, equal to 0·40 per cent. of the weight of the gas.

A German engineer finds 2 grammes of dust in the washed gas, or 0·16 per cent., after all possible means of purification have been applied, and at the Georg-Marienhutte, Oanabrück, an average of 2·91 grammes of dust or 0·23 per cent. was found in a cubic metre of washed gas.

A furnace producing 60 tons of foundry iron in 24 hours at Les Hauts Fourneaux et Fonderies de Pont-à-Mousson, evolves 12,358,500 cubic feet of gas, or 205,975 cubic feet per ton of pig-iron, which carries along with it 1,800 lbs. of dust.

equal to ·19 per cent. by weight, when the gases are reduced to atmospheric temperature and pressure.

At an ironworks in the Midlands where two furnaces produce about 460 tons of pig-iron per week, the estimated weight of heavy dust per week amounts to about 2½ tons. This dust accumulates in the flues and tubes, and is removed about every three months.

The gases evolved by the blast furnace are not the products of perfect combustion of the fuel, as the reduction of the oxides of iron is effected by carbonic oxide gas and carbon.

The air blast, on entering through the tuyeres of the furnace, comes in contact with highly heated carbon, and the oxygen of the air combines with this to form carbonic acid, while the nitrogen is not acted upon, but in the immediate vicinity of the tuyeres the carbonic acid gas formed comes into direct contact with more highly heated carbon with which it readily combines, forming carbonic oxide.

This carbonic oxide gas has the property of acting upon the oxides of iron, in a heated state, and reduces the iron to the metallic state, and under certain conditions some of the oxides are reduced by solid carbon, which results from the decomposition of the gases containing carbon. Without dwelling too long on the chemistry of the reduction of iron from its ores in the blast furnace, we may pass to the consideration of the evolved gases.

Firstly, the nitrogen of the atmospheric air employed, being an inert gas, passes out of the top of the furnace without any reduction in volume, and forms the chief constituent of the gases. Carbonic oxide gas is found to be present in a proportion generally not less than 25 per cent. by volume. In the operation of smelting, a certain proportion of the carbonic oxide gas becomes fully oxidised to carbonic acid, the proportion depending upon various conditions, but the limits are somewhere between, say, 6 per cent. and 12 per cent. of the total volume of gas evolved. Hydrogen is usually found to exist in blast furnace gases in small proportions, say, from 1 to 3 per cent., chiefly due to the decomposition of the aqueous vapour carried by the air blast in its passage through the furnace. However, when coal forms a constituent of the furnace charge, the proportion of hydrogen may be somewhat higher than that stated above, and the gases may also have small proportions of marsh gas, but for the purpose of this article, coke is assumed to be the fuel employed, so that the poorer class of gases may be taken as a basis.

Of the gases constituting blast furnace gas, only the carbonic oxide, hydrogen, and marsh gas are capable of generating heat by further combustion with air.

For the purpose of calculation, blast furnace gas having a percentage composition by volume, as follows, has been taken:—

Carbonic acid, CO_2	12
Carbonic oxide, CO	25
Marsh gas, CH_4	2
Hydrogen, H	1
Nitrogen, N	60
	100

The introduction of hot blast by Neilson was soon followed by the utilisation of the then "waste" gases for supplying the heat to the air blast by burning it in pipe stoves, and later in firebrick stoves, and means were adopted, though in some cases, even now, not very efficient, for preventing the evolved gas going to waste in the atmosphere. Some modern furnaces recover almost the whole of the gas, by means of the bell and hopper closed top charging arrangement, and a cover to prevent loss when the bell is lowered to admit the charge of materials for smelting into the furnace. The efficiency, therefore, of the methods adopted at the present time varies from a total waste of the gas in open top furnaces to almost perfect recovery in the best modern furnaces.

In the case of the ordinary closed top furnace, with bell and hopper, the number of times the bell is lowered per day of 24 hours may be, say, from 72 to 130, and the time the furnace top is open to the atmosphere each time the bell is lowered may be taken at half a minute; during this time the gas evolved is wasted, and the proportion lost will equal about 2·5 to 4·5 per cent. This proportion of waste can be reduced by having a cover for the hopper to be used when the bell is being lowered, as in the Thwaite-Gardner system.

(*To be continued.*)

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Sept. 26th, 1899.		Week ending Sept. 25th, 1900.	
Antwerp. Elec. fuse ..	Value £246	Adelaide	Value £186
Barcelona. Teleg. mat. ..	100	Amsterdam	155
Bombay	21	Bergen. Cable.	14,910
Buenos Ayres Teleg. mat. ..	295	Bombay	58
Calcutta	982	Brussels	86
,, Teleg. wire	112	Buenos Ayres	27
Cape Town	891	Calcutta	115
Channel Islands	8	,, Teleg. wire	126
Christiania. Teleg. wire ..	196	Cape Town	55
Colombo	208	Chili	200
Durban	546	Colombo	20
East London	73	Copenhagen. Teleg. wire ..	271
Ghent	24	Durban	231
Gibraltar	12	Fremantle	255
Gothenburg. Teleg. wire ..	29	Hamburg	110
Hong Kong	32	,, Teleg. mat.	500
Jamaica. Teleg. wire	78	Hong Kong. Teleg. mat. ..	302
Launceston	117	Kobe	296
Madeira	245	Lisbon	45
Madras	248	Madras	159
Malta	37	Melbourne	286
Melbourne	120	New York	300
,, Teleg. cable ..	514	Ostend	344
Montreal	25	Otago	78
Ostend	76	Port Elizabeth	25
Penang	145	Rotterdam. Teleg. wire ..	17
Perth	73	Singapore	40
Port Elizabeth.	28	Stockholm. Teleg. cable ..	2-3
,, Elec. cable ..	150	Sydney	545
Rotterdam. Teleg. mat. ..	100	Toronto	30
St. Petersburg	45	Wellington	94
Stockholm. Teleg. wire ..	100		
Sydney	848		
,, Teleg. cable	1,131		
,, Teleg. mat.	197		
Total ..	£8,047	Total ..	£19,859

Foreign Goods Transhipped.

Barbados. Teleph. mat. Value £106

Boiler Record Book.—In response to the request of many of their clients, the National Boiler and General Insurance Company, Manchester, have designed and issued a book for the purpose of recording cleanings, inspections, and repairs of boilers and fittings. The book consists of about 50 pages, ruled with compartments for the various particulars, and between each two leaves are half a dozen interleaves to which the company's reports may be attached. The whole should form a concise and systematic history of each boiler, conducing largely, it is to be hoped, to the prevention of accidents, and we have no doubt but that it will be of great use, not only to those for whose benefit it was primarily intended, but also to steam users in general.

Catalogues and Lists.—Messrs. Mather & Platt, Limited, send us a useful revised list of steel clad motors and accessories. This steel clad motor was especially designed to meet all practical conditions, and to conform to fire office requirements, and to be hermetically enclosed (water-proof and gas-proof) for exposed situations. The magnet casting forms a case which effectively protects the parts from injury. The motors are being made in several convenient sizes, for pressures ranging from 100 to 500 volts, and for various speeds. All parts are interchangeable, hence they may be quickly replaced from stock. The commutators are of a new and special design, giving large brush surface; the bars have a large radial depth, and carbon brushes are employed. Tables show the B.H.P. revolutions, voltage, weights and dimensions of different sizes of motors, also prices of accessories. Starting switches and speed regulators are also detailed. Another list to hand from the same firm describes briefly their exhibits at the Paris Exhibition. The illustrations are particularly pleasing.

Messrs. W. H. Allen, Son & Co., Limited, of Bedford, have published a neatly bound and excellently printed "Circular" (No. 5), which is entitled "Transmission of Power for Industrial Purposes by Electricity." High speed engines (enclosed) with continuous current dynamos, ditto. with multipolar dynamos, continuous current motors, enclosed and open, electric drilling machines, pumps, hoists, and switches, travelling cranes and condensing plants, and overhead transmission lines, are all well illustrated. A list of English central stations where Allen's engines, dynamos and motors are installed is given, and this is followed by several pages of useful information, showing in tabulated form the electrical H.P. required for driving different machines.

Messrs. G. Straus & Co., Limited, of Upper Thames Street, send us circulars of the "Siemens" incandescent lamps, also of Dr. Cassirer & Co.'s (Charlottenburg) electric light cables and flexible cords.

Circular No. 1,031 of the Westinghouse Company is devoted to belt-driven polyphase alternators, containing descriptions, with photographic illustrations and diagrams of connections, of their two and three-phase machines.

Liquidation.—A meeting of the Electrical Pioneer Syndicate will be held at Birmingham on October 25th to hear an account of the winding up from the liquidator.

Electric Fan.—In a note under the above heading in our issue of the 14th inst., by a slip of the pen we unfortunately gave the name of the fan makers as the "Sun Fan Factory." This should obviously have been the "Sun Fan Company, Limited."

Electricity in Fine Art.—One of the latest and most artistic applications of electricity consists in the combination of electric glow lamps with marble statuary. To accomplish this most satisfactorily, it is necessary that the design of the statuettes should be such as to harmonise suitably with the electrical fittings; and, on the other hand, the latter should be so disposed as to illuminate the

statuette to the best advantage, without appearing discordant or out of place in daylight. It is not sufficient to merely suspend a lamp from the marble with a festoon of flexible cord. Our illustration shows an example of statuary in which the above principles have been carried out. The original forms one of a number of similar *objets d'art* on view in the showrooms of Messrs. Max Emanuel & Co., of Shoe Lane, E.C.

Employers' Liability.—At the Loughborough County Court last week, before his Honour Judge Wightman Wood, John Knight, a mechanic employed at the Brush Works, Loughborough, applied through Mr. R. S. Clifford for a declaration of liability, which the respondents (Brush Electrical Engineering Company, Limited) admitted he was entitled to. Plaintiff's eyesight had been injured, and the company had paid him since the accident about the same wages that he was earning at the time of the occurrence. The Court was asked to make a declaration of liability, on the ground that he was suffering from permanent physical injury. Mr. Deane, for the company, said they admitted that the plaintiff was entitled to the order. They had made inquiries from the foreman, and he said the work done by the plaintiff since the accident had been perfectly satisfactory. If it turned out that he was not able to do his work so well he might have to take less money. His Honour, in granting the order asked for, said plaintiff had got all that he was entitled to. At the present time he was losing nothing through the accident. If he got less he had a right to come to the Court and get the amount put in. On the question of costs, in reply to Mr. Deane, his Honour said the company should have guarded against costs by tendering a memorandum agreement, signed by the plaintiff.

Municipal Trading.—The report of the Joint Select Committee of Parliament on Municipal Trading, with the minutes of evidence, was published on 17th inst. The recommendations of the Committee were confined solely to the expediency of reappointment next session, the matter being of too great a scope to be efficiently dealt with before the last prorogation. One of the most interesting documents in the volume just issued is the memorandum of Sir Courtenay Boyle, Permanent Secretary to the Board of Trade, on the relation of local authorities to electric lighting, gas and tramway undertakings. The *Financial Times* abstracts the report. As to electric supply by local authorities beyond their own districts, the Electric Lighting Act of 1882, Sir Courtenay says, provides that powers may be granted to authorities authorising supply in "any area, although the same or some part thereof may not be included within their own district." Powers have been granted by the Board of Trade to authorities in respect of their own district, and the whole or part of the district of another local authority in eight cases, and similar applications were made last session by three other bodies. The powers granted were all granted with the consent of the outside local authority, and in most cases the outside area is in the district of a rural authority. The Manchester Corporation in 1897 obtained power by Act to take, subject to the approval of the Board of Trade, transfers of electricity powers from local authorities of districts adjacent to the city, and by a further Act this provision was extended so as to include districts in proximity to the city. Similar power has since been given to five other Corporations, and like power was sought by three other Bills last session. Certain local authorities who have established electricity undertakings have obtained power by Act to supply energy in bulk to other bodies who are authorised to supply.

A local authority authorised by the Electric Lighting Acts to supply electricity can only borrow money for the purposes of the undertaking on the security of the "local rate." Powers granted to a local authority are subject to specific conditions as to the application of moneys received in respect of the undertaking. These conditions provide for the ordinary expenses of carrying on the undertaking and for the formation of a reserve fund. The reserve fund is limited to 10 per cent. of the capital expenditure on the undertaking. Any surplus remaining in any year after providing for ordinary expenses and for the reserve fund must be applied to the credit of the local rate, or to the improvement of the local authority's district, or to the reduction of moneys borrowed for the purposes of the undertaking, provided that if the surplus exceed 5 per cent. on the capital expenditure, a rateable reduction shall be made in the price charged to consumers of electricity. Any deficiency of income is chargeable on the local rate. Thus, where a local authority supplies outside its district, the effect is that that local authority is, in respect of the outside districts, in the position of a company—money raised on the security of the local authority's district is used for the purposes outside, and that district benefits or loses according to whether the whole undertaking is carried on at a profit or a loss.

The policy of the Act of 1870 with regard to the working of tramways owned by local authorities is indicated in Section 19, which provides that the local authority may either (1) lease the tramways to be worked by a company or person, or (2) leave the tramways open to be used by the public on payment of tolls. The section proceeds to enact as follows:—"But nothing in this Act contained shall authorise any local authority to place or run carriages upon such tramway and to demand and take tolls and charges in respect of the use of such carriages." This provision is merely negative, and is not a direct prohibition of working by a local authority. It did not deter local authorities from obtaining the power of working by special Act or provisional order without any necessity of repealing the general Act, and this power they have thus frequently acquired. In August, 1872, a new standing order was adopted by Parliament having the effect of the restriction against working by local authorities contained in the general Act. Procedure by Bill and by provisional order was thus placed on the same footing. Notwithstanding the uncertainty which prevailed with respect to Bills between 1870 and 1872, the policy of the restriction in the general Act commended itself to municipal administrators, and for 12 years all tramways constructed by local authorities were invariably leased to companies at an annual rental. The practice was unaltered until 1882, when the first exception—that of Huddersfield—arose, and the numerous applications made by local authorities on this precedent led to a reconsideration of the standing order, and after the passing of the London County Council and Leeds Bills in 1896, giving unrestricted power of working the tramways, the restriction in the standing order was dropped altogether at the end of the session, and since that date it has become the rule to confer on local authorities, both by Bill and provisional order, the power of working their tramways as freely as if they were a company, so far as their own district is concerned.

The next question which engaged attention was that of local authorities constructing or working tramways beyond their own boundaries. Under the pressure of circumstances and the applications for private Bills resulting therefrom, Parliament began in 1889 to confer on various local authorities powers of purchase and construction exercisable outside their districts, and in 1893 made a new standing order which, though negative in form, gave recognition to the principle of conferring such powers where the local circumstances seemed to the Committee on the Bill to justify it. In effect the standing order provided that tramways in one district might be authorised to be constructed, acquired, or taken on lease by the local authority of another district, if the projected lines were continuous with lines belonging to the local authority promoting the Bill. A powerful impetus was given to this movement by the adoption in recent years of an inexpensive form of electric traction for tramways. Many local authorities possessed installations for electric lighting, and owing to the tramways being mainly a "day load" and lighting a "night load" on the electrical generators, the economical advantage of working both together became very considerable. It enabled a local authority with an electric installation and working a tramway system to offer tramway facilities to small neighbouring places who could never think of setting up a system of their own. On the general question it might be added that the annual returns of tramway traffic, published by the Board of Trade, show that the working of tramways by local authorities has been a success so far as it has gone.

It is not supposed that these favourable results were entirely due to municipal as against company working. No small part of the success achieved by the municipalities is due to the fact that their

taking up the working has synchronised with the introduction of a cheap and attractive method of electric traction. With regard to the results of powers exercisable by local authorities beyond their districts, there has, up to the present time, been no sufficient experience to afford proper data for an opinion.

Notice.—Attention is directed to a notice among our advertisements this week regarding one named Harvey and the Hertfordshire Engineering Company, Limited.

The Paris Exposition.—Messrs. Geipel & Lange inform us that the following specialities, for which they are agents, have obtained distinction at this exhibition:—The Geipel trap heads the list with the distinction of Hors Concours, and it was employed exclusively for draining the whole of the steam pipe system, for which no less than 80 traps were used; Brown-Boveri three-phase plant obtained Grand Prix; the Ward-Leonard was the only apparatus of this type to obtain a Gold Medal; the Vulcan meter also obtained a Gold Medal; and the Chapman voltage regulator, which only formed part of a general exhibit of American products, a Bronze Medal.

Shaft Fractures. — From observations made on fractured crankshafts, Mr. M. Longridge considers that cranks should be secured to their shafts, particularly when these are of steel, by means of round pins sunk half in the shaft and half in the crank rather than by rectangular keys, fracture being very apt to commence from the corner of a rectangular keyway. The pin may not be so mechanically good as a transmitter of stress, but then cranks should be properly shrunk on, and the key is only a stand-by in the event of it working loose. Three cases of broken shaft are referred to. Failure occurred at 111,400,000, 116,000,000, and 123,000,000 revolutions respectively. The stresses per square inch were 11,000, 7,050, and 6,600 lbs. respectively. The first shaft probably had a less stress than 11,000 lbs. in the early days of its life. In the case of a broken crosshead with a stress of 15,600 lbs. per square inch each way or a range of 31,200 lbs., breakage occurred with 46,000,000 applications of stress or 23,000,000 each way. Another crosshead broke at a stress of 11,250 lbs. The stress had been 7,400 lbs. up to an alteration being made in the engine. Before the alteration the engine made 101,000,000 revolutions; after the alteration about 47,000,000 revolutions were made.

There is evidently an attempt made to study the important subject of engine breakdowns on the lines upon which Wöhler worked, lines along which many other experimenters have also worked, and that are deserving of further attention from engineers than has been accorded them hitherto, though there can be no doubt that the behaviour of materials under various stresses has amply demonstrated that different applications of stress have widely different results, and that range of stress is important quite as much as any maximum stress of more steady application.

Technical Education.—The calendar for the fifth session (1900-1901) of the Royal Technical Institute at Salford is now obtainable (4d.) on application to the principal. As usual, it gives full details of the electrical engineering and other courses and classes, accompanied with photographic illustrations of the different departments.

Trade Announcements. — The Machinery Trust, Limited, have, in connection with their business, a special department for the supply of electric motors, dynamos and electrical fittings. They are in a position to undertake complete installations, or any part of same.

The head offices of the National Telephone Company have been removed to Telephone House, Victoria Embankment, E.C.

Wheeler Cooling Towers.—Orders for cooling towers have recently been given to the Wheeler Condenser and Engineering Company as follows: — For the Newcastle-upon-Tyne Electric Supply Company, cooling tower of 2,000 H.P. capacity; Messrs. Platt Bros., Limited, Hartford Mills, Oldham, 1,000 H.P. capacity; Bromley electric light station, 1,000 H.P. capacity; Southend-on-Sea Corporation light railway, 1,000 H.P. capacity. In the two latter cases contracts also include equipment of condensing plants, exhaust oil separators, feed water heaters, the cooling towers being of the fan-driven type.

ELECTRIC LIGHT AND POWER NOTES.

Aberdeen.—In a recent report to the Aberdeen Gas and Electric Lighting Committee, the electrical engineer, Mr. J. A. Bell, refers to the provision which it will be necessary to make for laying feeder and pilot cables from Dee Village to the different feeding points. He discusses the different ways in which the cables can be laid, and recommends the Committee to authorise the building of a concrete subway above the new sewer which is to be laid in Crown Street and Portland Street, which will prevent the road being opened more than once. He estimates the cost of the subway at £5,400 to £6,600, according to the design adopted. The Committee have recommended the Council to sanction the construction of the subway as proposed at £6,600.

Alloa.—The Burgh Commissioners, having considered a report drawn up by Messrs. Buchan & Hogarth, Edinburgh, have decided to apply to the Secretary for Scotland for leave to borrow £12,000 for the purpose of carrying out an electric lighting scheme.

Annfield Plain.—The U. D. C. last week consented to the Northern Counties Electrical Supply Company applying for a provisional order to supply the district with electricity.

Ayr.—In his annual report Mr. Fuller, the electrical engineer, says that experience has proved that the quality of the coal in the district renders it necessary to have more boilers than originally intended. The output from the works increased by 43 per cent. from 297,420 units to 425,639 units, and a substantial reduction has been made in the generation cost per unit, in spite of a large increase in the cost of coal, &c. The figure for this year is 1·8d. against 2·03d. last year. After paying £1,530 interest on capital, £235 is left for the annual sinking fund. In another report the borough electrical engineer enters into the question of the best method of dealing with the extension of plant required for the tramways, coupled with the proposal to alter the central area into a low tension continuous one. His report is split up into four sections dealing with (1) extra plant required for tramways; (2) cost of alterations to mains; (3) extra plant required if low tension be adopted; (4) account to be charged with same. In regard to (1) he gives the estimated cost of the necessary plant and accessories for tramways as follows:—Two 150-KW. continuous current generators—£1,800 each, £3,600; steam and exhaust piping, £250; switchboard and connections, £550; one water-tube boiler, £700; one pump, £40; one condenser, £500; pipework for boiler house, condenser, steam, feed and exhaust, £250; building for boilers and all foundations, £1,500—£7,390.

Regarding (2) he says that the amount of cable required to meet this change of the system, and also to deal with future extensions, equally four times the capacity of the present cables, would be about 7,000 yards of distributing main cable, and to this must be added about 2,500 yards of feeders. In fixing the size of these he has estimated them with a view of meeting all the demand likely to arise in the district during the next five or six years, but if desired, the cost (as given below) could be reduced by only putting down cables to deal with the next two years following the laying of the cable, but this is a scheme he would not at all advise. The cost of this change over in the streets would be as follows:—500 yards, two feeding cables, £612; 6,800 yards, one distributing cable, £1,292—£1,904.

Respecting (3), if the change is made, it will be necessary to place on order the following:—one 150-KW. generator, £1,800; one booster, £250; one boiler and economiser, £1,200; one set accumulators, £800; one switchboard, £450; connections, sundries, &c., £200; one balancer, £300—£5,000. By allowance from Messrs. Siemens, say, £1,500—£3,500. With a view to facilitating delivery of the tramway generators, and also to avoid any trouble with Messrs. Siemens as to the change of No. 3 plant, he suggests entering into communication with them with a view of obtaining the whole of the dynamos from their works. If the above system be not passed it will be necessary to sanction the contract already entered into with Messrs. Siemens for one 200-KW. alternator. If alternating plant be put down the present engine room would not hold the dynamos required for the tramways, but an extension of the building would be necessary; this is a very important point, and should not be overlooked.

Summary.—Estimating from the above the amount required for extension would be as follows:—Proposed extension of mains, £1,904; proposed L.T. plant, £5,000; plant for tramways, £7,390—£14,294. Less allowance No. 3 plant, £1,500—£12,794.

The reports were referred to committee with power to act.

Barnstaple.—The Town Council has appointed Mr. Adams to report on the electric lighting of the borough for a fee of 25 guineas.

Benfieldside.—The U. D. C. has consented to the application of the Northern Counties Electrical Supply Company for a provisional order to supply electricity in the district.

Birstall.—A private company has given notice of its intention to apply for powers to supply electrical energy in the district, and, in order to keep it out, the Council has decided to apply for a provisional order.

Bournemouth.—The Lighting Committee of the District Council, at their meeting on 11th inst., recommended that the town clerk be instructed to open negotiations with the Bournemouth and Poole Electricity Supply Company, for the purchase of their undertaking.

Bowness.—A meeting of electric light users was held at Windermere last week to consider the proposed increase of the price from 6d. to 7½d. per unit. Those present pledged themselves to discontinue using the light after October 1st, unless the Windermere and District Electric Supply Company withdraw the notice of increase.

Bristol.—A serious difference of opinion has arisen between the electrical engineer and the architect with regard to the foundations for the Corporation's new electricity works at Avonbank. Finding that the points in dispute are of an important and complicated nature, the Electrical Committee has recommended the Council to refer the question to Sir Benjamin Baker for decision.

Buxton.—Owing to the increasing demand, the electricity works are now no longer able to supply the requirements of consumers, and the Electricity Committee, acting on the report of Mr. Calvert, electrical engineer to the Council, has recommended a further expenditure of £25,000 for additional plant. Some dissatisfaction has been expressed with the public arc lighting.

(*Continued on page* 511.)

powers may be granted to authorities authorising supply in "any

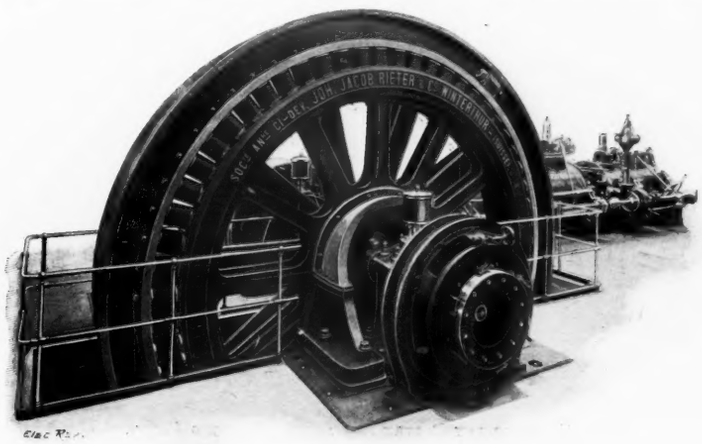
success achieved by the municipalities is due to the fact that their

THE PARIS EXHIBITION.

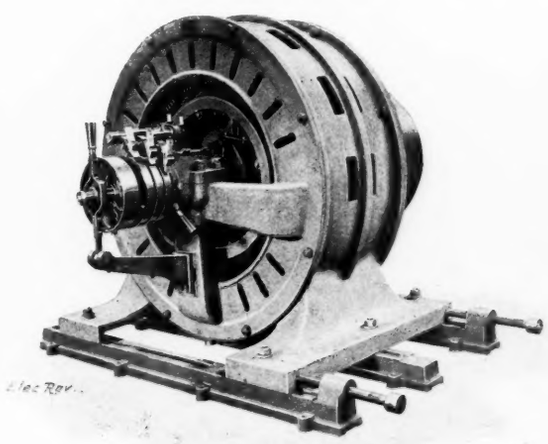
Exhibit of J. J. Rieter & Co., Winterthur.

Messrs. Rieter & Co. will probably be best known to our readers as makers of hydraulic machinery. Some time ago, however, this enterprising firm added an electrical department to their business, and the energy with which they have taken up the manufacture of electrical apparatus is well shown by the various exhibits they have sent to the Exhibition.

We illustrate herewith a number of the items of their exhibit. The alternator shown in fig. 1 is coupled to a tandem compound Sulzer engine of 750 h.p., running at 100 revolutions per minute. The machine generates three-phase current at 3,300 volts and 50 cycles per second. There are 60 poles attached to the inner periphery of the fly-wheel rim by bolts, which latter are of small section, as they have not to take any stress due to centrifugal force, as is the case in usual alternator construction. Each pole is wound with 137 turns in six layers of copper wire 6 mm. square. The exciting current is 55 amperes, and is provided by a 12-pole exciter fixed on the end of the crankshaft. The armature is supported on an extension of the outside bearing, and it is in two parts for convenience in mounting. The general construction, it will be noticed, is somewhat similar to that of the Niagara generators, inasmuch as the magnetic pull of the poles on the armature opposes centrifugal force. It is a design which is particularly suitable for single-crank engines, because the fly-wheel can be made of very massive proportions.



800-kw. Three-phase Alternator at Paris.



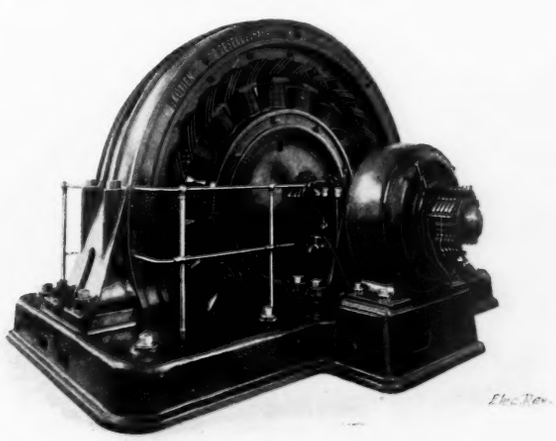
200-h.p. Three-phase Motor (420 revolutions) at Paris.

THE NEW ELECTRICITY WORKS OF THE GLASGOW CORPORATION.

(*Continued from page* 470.)

We give on page 508 a view from the middle of the engine room looking southwards; in the foreground is one of the Belliss-Thomson-Houston 1,500-h.p. generating sets described in our last issue. The condensing plant belonging to this set is seen to advantage on the left hand, as well as the arrangement of the steam and exhaust pipes; a similar condensing set is connected with each of the other two 1,500-h.p. sets seen in this view.

The condenser shell is a cast-iron cylinder, with a cooling surface of 2,550 square feet; the tubes are of solid drawn brass fixed into brass tube plates. The air pump, of which we give a separate view, is a three-throw Edwards pump driven through Hollick gear by an electro-motor, and running at 160 revolutions per minute; each of the pump barrels is 12 inches in diameter, with 12 inches stroke, and all the parts liable to corrosion are of brass. The effective displacement of the pumps is 2·36 cubic feet per revolution. The small force pump seen at the side of the air pump is used for lifting the water from the air pump delivery valves to the tank in the boiler house, to which we have referred above.



500-h.p. Three-phase Alternator with Direct Driven Exciter. (300 revolutions.)

The circulating pump is of the "Conqueror" centrifugal type, with suction and discharge branches 11 inches in diameter; the diameter of the impeller is 17 inches. The pump spindle is direct coupled to an electro-motor, taking about 8·5 amperes at 520 volts at full load; the air-pump motor requires 10 amperes under the same conditions.

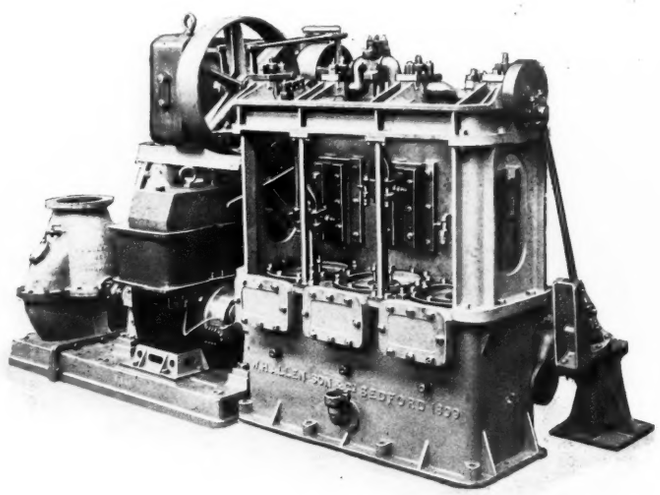
Behind the two Belliss engines are seen the tapering cylinders of a Willans engine coupled to a Crompton multi-

£12,000 for the purpose of carrying out an electric lighting scheme.

(Continued on page 511.)

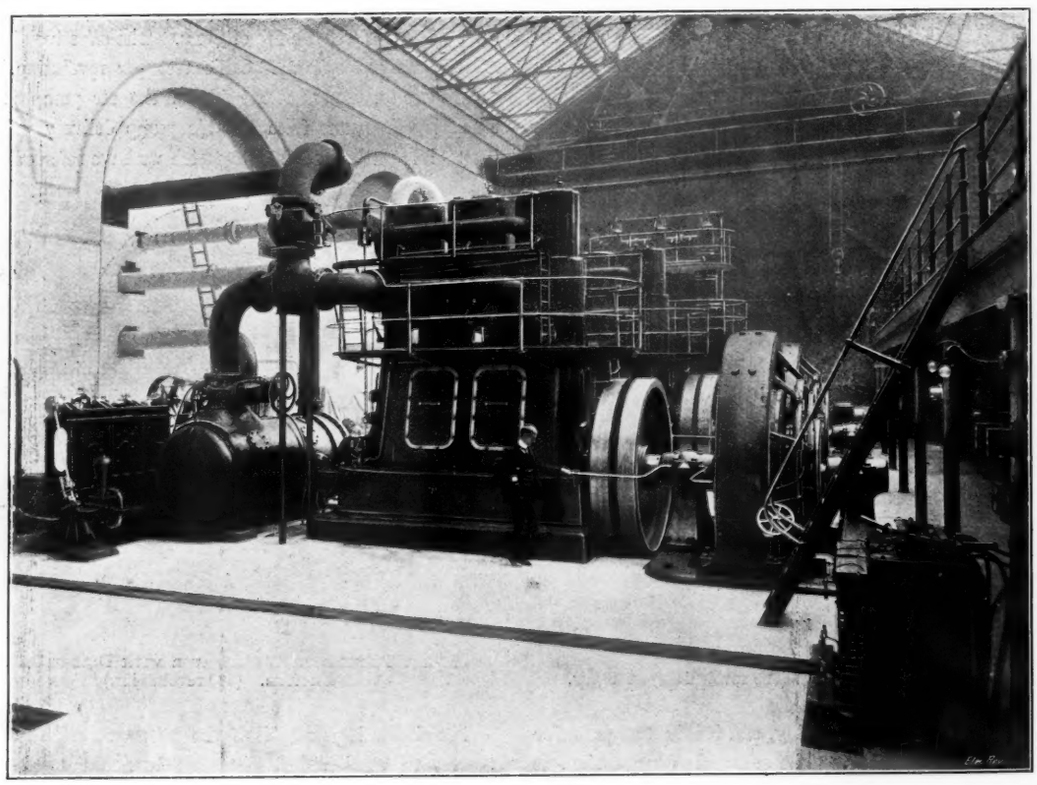
polar generator. This engine is of the triple-expansion single-acting type, size 3V, with a normal output of 1,200 I.H.P., maximum output 1,500 I.H.P.; the cranks are three in number, each driven by three cylinders in tandem, for high, intermediate, and low pressure, with diameters of 380, 600, and 950 mm. respectively. The engine is designed to give the rated output with a pressure of 180 lbs. per square inch at the stop valve, and at a speed of 230 revolutions per minute.

The generator is of Messrs. Crompton & Co.'s latest type, with 12 poles, compound wound to give 1,200 amperes at 610 volts; the mean working pressure, however, as a shunt-wound machine is 520 volts, at which pressure a current of 1,400 amperes is generated. As a compound traction generator the output ranges from 500 volts at no load to 550 volts 1,400 amperes full load. The magnet frame, contrary to the ordinary practice, is of cast-iron, and is divided into four parts, as seen in our view of the dynamo; the poles are of wrought-iron, and the series winding is carried round the shunt, with a clearance of an inch or thereabouts, giving ample ventilation. The armature is, as usual, of the toothed core barrel-wound type, 7 feet 6 inches in diameter, and weighing 18 tons; there are 1,500 conductors of copper strip, bent to shape on formers before mounting in the core, and divided between 250 slots. The commutator has 750 sections, and is of massive construction. It is noteworthy that while the other large sets are all provided with heavy fly-wheels, the armature of this generator is so heavy that no separate fly-wheel has been found necessary. The same principle of extra substantial construction has been adhered to throughout the design of the machine, and cannot fail to add to the life of the generator. The combination is capable of working up to 960 KW. (1,900 amperes at 510 volts) for an hour or two when necessary; the engine, which presents a striking appearance, is fitted with automatic cut-off gear of the latest type.



Electrically Driven Air and Circulating Pumps.

This completes the list of generating sets at present installed in the station; but very important additions are in hand in the shape of two Willans engines of the 3 X size, coupled to Westinghouse generators of 1,400-KW. output each. These engines are exactly similar to the one shown at the Paris Exhibition, of which we gave a brief description and an illustration in our issue of May 4th, 1900. Each engine is of the triple-expansion three-crank condensing type, having nine cylinders in sets of three, of 480, 770, and 1,220 mm. diameter respectively; the normal output is 2,400 I.H.P., at a speed of 180 revolutions per minute, and



Looking Southwards: Three 1,500-H.P. Generating Sets.

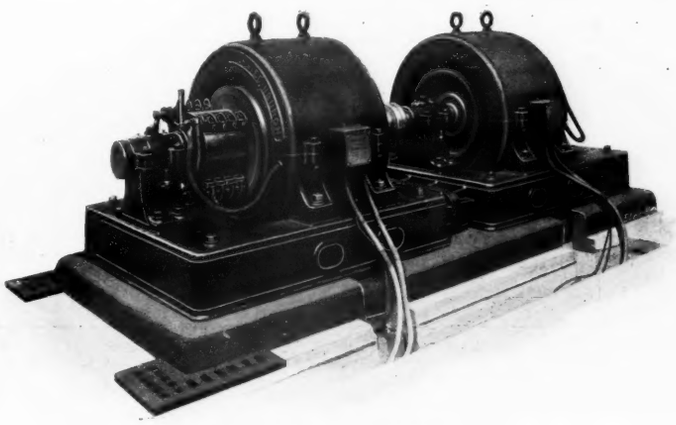
portions.

cylinders of a Willans engine coupled to a Crompton [illegible]

F

the maximum output 3,000 I.H.P. The dynamos are of the Westinghouse Electric and Manufacturing Company's standard shunt and compound-wound type. Foundations are being put in at the north end of the engine room for these large sets, which will be erected during the coming winter, and will complete the electrical equipment of the present building.

The engine room is traversed by a 25-ton travelling electric crane, constructed by Messrs. Broadbent & Sons, of Huddersfield, and partly shown in our view looking southwards. The crane is operated by a single enclosed motor of 17-H.P., running at a speed of 600 revolutions per minute, and made by Messrs. Bruce Peebles & Co. The motor is mounted towards one end of the crane girders, and drives by a single rope a pulley near the opposite end; the latter is keyed to a transverse shaft by which the various motions are operated with fast and loose pulleys and leather belts. To convey the power to the crane two copper wires are stretched from end to end of the room, and are so arranged as to be lifted by under-running shoes carried on the crane.

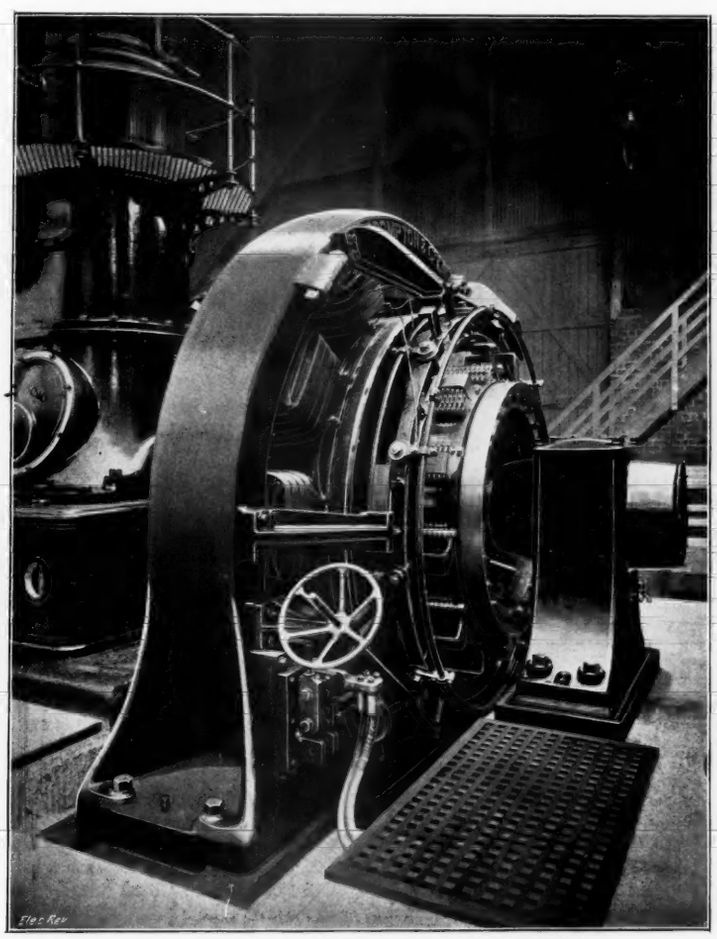


Peebles 150-kw. Balancer.

We turn now to the smaller auxiliary electrical machines. These consist of two battery charging booster sets and two balancers. The former are seen in the foreground of our view towards the north end of the engine room, published in our last issue; each consists of a generator capable of giving 225 amperes at 160 volts, at a speed of 850 revolutions per minute, coupled to a motor taking up to 85 amperes at 500 volts. Both machines are of Messrs. Mavor and Coulson's standard two-pole type, with "Manchester" field magnets and Sayers armatures. The starting switch gear in connection with them is seen close by the machines.

In the same view there may be seen a balancer made by the India-rubber, Gutta-percha and Telegraph Works Company, Limited; this consists of two machines of identical dimensions, each rated at 150 amperes, 300 volts, at 650 revolutions per minute. They are compound-wound, and work sparklessly at all loads.

It is interesting to note that all the machinery shown in the view last mentioned was erected upon concrete foundations, as it now stands, before the station buildings were put up. A temporary wooden shed provided with a 7-ton traveller was erected to act as a shelter over the foundations, and in this the plant was put up and worked continuously from December, 1898, to November, 1899. By that time the main buildings were sufficiently completed to allow of the removal of the shed, and at the same time the large travelling crane was erected. All the plant shown in our southward view, as well as the remaining balancer, has been installed since last December.



Crompton 720-kw. Dynamo.

The last-named machine is of Messrs. Bruce Peebles & Co.'s manufacture, and is shown in one of our views herewith. It consists of two 4-pole dynamos of the makers' standard type, each capable of giving 500 amperes at 250 to 300 volts, and running at 600 revolutions per minute. The pole-tips are specially shaped for the prevention of sparking at the brushes. The large starting resistances for these two machines are shown in the foreground of one of our illustrations; it will be seen that the starting switches are coupled together, putting both machines on the mains at once. The apparatus is complete in itself, and is provided with a set of Kelvin measuring instruments.

From our illustrations it will be seen that all connections to dynamos, &c., are carried underground in culverts, everything that can with advantage be concealed beneath the floor being so placed. A small portable air compressor driven by a motor is used for cleaning the dynamos by means of an air-blast.

(To be concluded.)

and weighing 18 tons; there are 1,500 conductors of copper

is 2,400 I.H.P., at a speed of 180 revolutions per minute, and

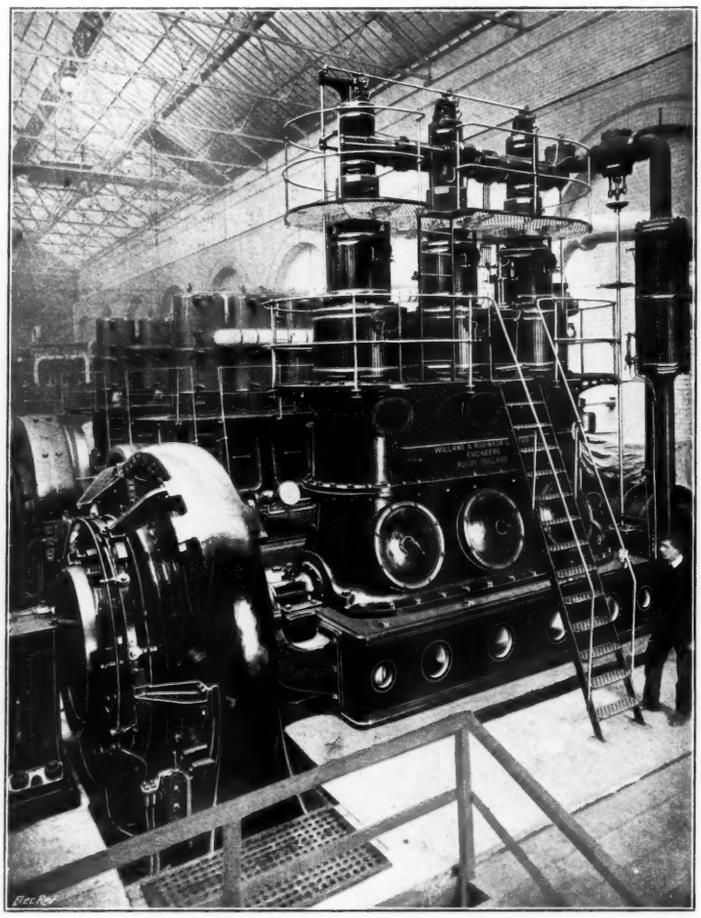
REVIEWS.

The Inventor's Adviser, or Every Man's Own Patent Agent. By Reginald Haddan, Fellow of the Chartered Institute of Patent Agents. London: Harrison & Sons. Fifth edition.

This excellent work, which has been re-christened so as to bear the alternative title of "Every Man's Own Patent Agent," has gained much on its fifth passage through the press. It is sometimes said that the man who is his own lawyer has a fool for a client; and the anonymous author of "Every Man's Own Lawyer," is often called the author of a guide to litigation. Neither of these adages could be justly applied to the result of Mr. Haddan's labours. His little volume has proved itself to be of infinite value to the inventor who is unable to obtain the assistance of a patent agent, and to the patent lawyer, who uses it as a lamp to throw light upon the commercial aspect of letters patent for inventions.

The fifth edition is divided into four parts. Of these the first comprises a treatise on the commercial aspect of inventions and patents. In Chapter VI. the author takes care to point out to the inventor the reason why it is to his interest to go to the expense of taking out letters patent for an invention. He also draws attention to the various methods by which a patented invention can be sold for profit, while the rules for ascertaining the commercial value of a patent are set forth in Chapter VII. As the author truly remarks in the Preface, the contents of Part I. "are altogether new in works on patent law."

Part II., which is devoted to the British Law of Patents, is a veritable *multum in parvo*. While he deals with all the material questions which should be brought to the knowledge of the would-be patentee, Mr. Haddan never loses sight of the fact that he is addressing a reader who comes to the perusal of his work unbiassed by any previous knowledge of the subject. In particular, we think the author's treatment of the rights of licensees is particularly lucid and satisfactory. Another important question has also been treated of, namely, the right, if any, of a workman to take out letters patent for inventions discovered by him when in the employment and with the materials of his master. In dealing, shortly, with the question of infringement, we think Mr. Haddan has exercised a wise discretion. As soon as the institution of, or defence to, legal proceedings becomes necessary, the prudent inventor should always take professional advice. An attempt to dispense with that advice is usually attended with disaster to the unfortunate inventor or the alleged infringer.



Glasgow.—Willans-Crompton 1,500 I.H.P. Steam Dynamo.

Where all is excellent, it were invidious to single out any particular portion of the work for the greatest amount of praise. We are of opinion, however, that Part III., which deals with foreign patents, is likely to continue to be the most important part of this volume. Here, arranged in alphabetical order, may be found all the countries of the world, which are able to boast a system of patent law. A short epitome of each system enables the British patentee to decide whether it will or will not be worth his while to seek foreign protection for the result of his inventive genius. The necessity for foreign protection increases year by year. England, which has for centuries taken the lead among the manufacturing countries of the world, was the first to institute a system of protection for the benefit of the inventor. That system has been copied, with greater or less modification, in every manufacturing country—and these countries, slow to take the initiation, but quick to follow a good example, are ever ready to pounce upon and adopt inventions which they can turn to good advantage. With Mr. Haddan's book in his hand, the inventor can easily decide whether to seek protection abroad as well as at home.

The fourth part, which deals with trade marks and designs, and the laws relating to the same in all the principal countries in the world, would have justified Mr. Haddan in expanding the title of his work. There are few subjects which are less known than the law of trade marks, and we venture to think there are few books in existence which deal so concisely with this branch of the commercial law.

In the first appendix may be found a useful list of British and foreign authorities on the law of patents. To that list may be added "The Law and Practice Relating to Letters Patent for Invention," a monumental work by Messrs. Roger Wallace, Q.C., and J. Bruce Williamson, only published this year. The second appendix contains all the forms likely to be used either at home or abroad by patentees—those in use abroad being printed in their native languages. The third appendix contains useful hints with regard to drawings which should accompany an application for a patent.

In conclusion, we confidently recommend this work to all those who take a practical interest in patented inventions.

Gas Lighting. By Charles Hunt. London: J. and A. Churchill. 1900.

This new work, being Vol. III. of "Chemical Technology," edited by Charles Edward Groves, F.R.S., and William Thorp, B.Sc., is by Mr. Charles Hunt, manager of the Birmingham Corporation gasworks. It is admirably printed and illustrated, there being two plates and 292 illustrations

pany, Limited; this consists of two machines of identical

(*To be concluded.*)

(inclusive of diagrams). The manufacture and purification of gas and its bye-products is more fully treated of than the title would suggest, and the data given in connection with its application to lighting must bring the work prominently forward now that the relative advantages of gas and electric light are being so eagerly compared.

Laboratory Note-Book for Chemical Students. By V. B. Lewes and J. S. S. Brame. London: Archibald Constable & Co.

While this is called a note-book, and is interleaved with blank pages for the purpose of making notes, it partakes still more of the nature of a text-book, there being 170 pages of printed matter. Part I. consists of brief instructions on the preparation and properties of the commoner gases, &c.; Part II. deals with the analysis of simple salts, and Part III. is devoted to experiments of a quantitative character. Towards the end of the book sections on the valuation of fuels, tests of lubricating oils, and the examination of explosives are included.

While it is in our opinion questionable whether the combination of note-book and text-book is of advantage, the instructions possess the merits of brevity and clearness, and are eminently practical.

Electric Lamps and Electric Lighting. By J. A. Fleming, M.A., D.Sc., F.R.S. London: *The Electrician* Printing and Publishing Company, Limited. 1899. Second Edition.

This is a re-issue of the work founded on a course of four lectures on "Electric Illumination," delivered by the author in 1894 at the Royal Institution. It has been corrected and brought up to date by the addition of paragraphs where necessary. Although, to suit the audience before which the lectures were delivered, the matter necessarily partakes more or less of the "popular" style, it would be a mistake to suppose that there was not in the book an abundance of information of interest and value to technical readers.

As we reviewed the first issue some years ago, we may confine our remarks on this occasion to a few special features. A valuable section is that which deals with the guiding principles of artistic illumination, and explains how, through the instinctive contraction of the pupil of the eye in the presence of a bright light, a brilliantly lighted room may yet be very badly lighted for practical purposes. A simple test of the effectiveness of the distribution of light in a room is made by holding a pencil vertically on a white surface, and noting whether any marked shadow is thrown on the latter. In the author's opinion, while no definite rule can be given, a fair allowance is one 16-c.p. lamp at a height of 8 feet for 50 square feet of floor space; the use of a number of lamps "hung head downwards by cord pendants" is severely condemned from a decorative point of view.

A considerable addition has been made bearing on the subject of high voltage lamps, and a brief account is given of the Nernst lamp and others of a similar nature. The section on arc lamps has also been extended, and includes a discussion of the experiments of Mrs. Ayrton and Victor von Lang. On the other hand, we read, with pained surprise, on p. 181, that a 10-ampere lamp "will use 500 watts per hour, or 1 Board of Trade unit in every two hours."

Enclosed arcs form the subject of a new section, and the phenomena of the alternating current arc are briefly reviewed.

The last lecture deals with distribution, and gives examples of various typical systems. Several new forms of supply meter have been introduced, and the Wright system of charging is explained.

The book is handsomely bound and well illustrated, and altogether forms a very useful and interesting epitome of the art of electric lighting.

ELECTRIC LIGHT AND POWER NOTES.

(*Continued from page 506.*)

Carmarthen.—The Electric Lighting Committee is asking "three eminent engineers" to state their terms for advising the Council as to the cost of an electric lighting scheme.

Coventry.—The quarterly statement of the Electric Light Committee shows an extraordinary increase in the amount of energy supplied during the quarter ending June 30th, as compared with the corresponding period last year. In the past quarter the amount was 45,616 units; in the June quarter, 1899, the supply was 18,925 units, showing an increase of 26,691 units. The number of consumers has increased from 147 to 277.

Enfield.—The District Council has resolved to apply to the Board of Trade for a provisional order for electric lighting, and has appointed a committee to consider the various proposals submitted by companies for the supply of electricity in the district. Enfield is one of the five authorities which are promoting a joint scheme.

Farnworth.—Considerable progress has been made with the new electricity works of the District Council. The machinery is to consist of three Lancashire boilers, each 30 feet × 7 feet 6 inches, three steam dynamos of 120 kw. each, and a storage battery of 250 cells. The total cost of the works and cables is expected to be £22,000. The scheme includes the supply of power to the electric tramways, for the construction of which the District Council has obtained Parliamentary powers.

Germany.—A 4,000-h.p. steam dynamo has just been erected and put to work in the Upper Spree central station of the Berlin Electricitätswerke Gesellschaft.

Hampton.—A report on the question of electric lighting in connection with a refuse destructor has been submitted to the District Council by Messrs. Handcock & Dykes, of Westminster, and Mr. Kemp, surveyor to the Council. A scheme for the supply of 3,000 8-c.p. lamps is drawn up, with feeders for 10,000, and public lighting with 250 glow lamps is provided for. The total estimated cost of the generating station and mains is put at £15,450, and for the destructor £3,425.

Hanley.—Mr. H. P. Boulnois has just held an inquiry into the application of the Town Council to borrow £9,500 for the provision of a refuse destructor, and £4,500 for the purposes of electric lighting. During the last seven years the sum of £64,990 have been borrowed in various amounts for the latter undertaking. There has been much dissatisfaction in the town, on account of a supposed loss to the ratepayers of £2,690; and at a recent meeting of the Council a resolution to call in an expert was only lost by 10 votes to 12. Mr. Cowell, the engineer, however, alleges that what was stated to be leakage was really loss in transmission and in transforming. Mr. Boulnois said he perceived the local feeling, though he doubted if the Corporation had power to call in an expert. He would, however, note the suggestion to the Local Government Board.

Harrow.—The *London Gazette* contains notice of the intended transfer of the 1900 provisional order from the District Council to the Harrow Electric Light and Power Company.

Hexham.—The District Council has appointed a committee to consider the question of electricity supply.

Maidstone.—Sir W. H. Preece, visiting Maidstone last week for the purpose of reporting on the electric lighting scheme for the borough, expressed himself pleased with the scheme, but did not favour the combination of a dust destructor with the electric lighting station.

Manchester.—As if the destruction of the telegraphs at the G.P.O. were not enough, a breakdown of the electricity supply took place on Wednesday last week over a large area, at about 8 p.m. Prompt steps were taken to locate the trouble, and portions of the city were successively connected up, almost all the circuits being restored by 7 a.m. next morning. The fault was stated to be originally due to the breakage of an insulator on one of the bare copper mains. Another failure occurred on the following evening at 4.30, but was of a more local character. Mr. Wordingham being in Paris with the chairman of the Electricity Committee, the work of repair devolved upon Mr. A. A. Day, chief assistant, who, we may add, was due to take up the post of chief engineer at Bolton this week.

Northfleet.—The Urban District Council is considering the question of obtaining a provisional order for the lighting of the district with electricity.

Pontypridd.—A Sub-Committee of the District Council has recommended that the Council obtain electric lighting powers.

Sevenoaks.—The Urban District Council has deputed a sub-committee to settle terms with the Electrical Power Distribution Company, Limited, for the taking over of the Council's provisional order.

Sheffield.—Prof. W. Ripper, principal of the Technical School, who has recently paid a visit to the Paris Exhibition, attended the meeting of the Electric Light Committee of the Corporation on Tuesday to give the members the benefit of his observations of the electric generating machinery on view there. Prof.

usually attended with disaster to the unfortunate inventor or the alleged infringer.

and illustrated, there being two plates and 292 illustrations

Ripper went to Paris on behalf of the Technical Instruction Committee to gather information as to the methods of instruction pursued by other countries. He will report to a meeting of this Committee later. Meanwhile he on Tuesday gave the Electric Light Committee some interesting facts and criticisms on a matter which is just now engrossing much of their attention—giving his opinion on the comparative merit of the various kinds of generating machines exhibited in Paris. Mr. S. E. Fedden, the manager of the electric light department, is now in Paris pursuing similar inquiries.

Shipley.—The Council has accepted tenders amounting to £7,697 for works in connection with the electric lighting installation, subject to the approval of the Local Government Board.

Southgate.—The District Council has resolved to apply for a provisional order for electricity supply. Southgate is one of the five or six authorities which are combining in a joint electric lighting scheme.

Southport.—The Electricity Committee has decided to ask the Council to raise the salary of the electrical engineer, Mr. C. D. Taite, from £300 to £400 per annum, lest he should be tempted to seek a more lucrative appointment elsewhere.

Tewkesbury.—The Town Council has decided not to apply for an electric lighting provisional order.

Wellington.—At a meeting of the Council last week, the special committee appointed to consider the advisability of taking steps to supply electricity in the district recommended the Council to apply for a provisional order.

Wrexham.—The Corporation has issued to the public a pamphlet on the various applications of electricity, explaining briefly its uses for shop, office, and church lighting, and for the lighting of private premises. The electric cooking and heating application is by no means laboured, for it is dismissed in six lines, but electricity for driving machinery and tools is rightly dwelt upon at, comparatively speaking, considerable length. The comparative merits and prices of gas and electricity are mentioned. The Corporation does not do "free" wiring work, but recommends several companies who will do such work on the hire-purchase system.

Wisbech.—The Town Council has resolved to apply for an electric lighting provisional order.

ELECTRIC TRACTION NOTES.

Brighton.—In connection with the tramway scheme the tramways engineer (Mr. T. B. Holliday) reported that he had prepared an estimate of the cost of paving the tramways area; for the space between the rails and for a distance of 18 inches on the outside of the outside rails he had provided for Jarrah wood paving on all tramways where the gradients did not exceed 1 in 20, and where the gradients were in excess of this he had provided soft wood paving. The total tramway area was 56,768 $\frac{8}{9}$ths super. yards, and the paving area 52,786 $\frac{8}{9}$ths super. yards, and he estimated the total cost at £44,067 16s. The report was approved, and the work ordered to be carried out by contract.

Bristol.—A party of members of the Institution of Mining Engineers visited the Bristol Tramways Company's electric power station at Counterslip on 19th inst. It was stated that the installation would be complete in about a month's time.

Cardiff.—At a special meeting of the Town Council on Monday the report of Mr. Arthur Ellis, the electric traction engineer, was confirmed, and he will now proceed with the preparation of the specifications for power stations, car depôts, plant, overhead electrical equipment, &c.

The Central London Railway.—The Bond Street station was opened on Tuesday, thus making every station of the Central London Railway available for public traffic throughout its entire length from the Bank to Shepherd's Bush.

Glasgow.—The Corporation has relieved Messrs. A. Thomson & Sons of their contract for bricklaying and other work at the Pinkston power station, and has remitted it to the town clerk and general manager of the tramways undertaking to have it completed. It was stated at last week's meeting that all the work in connection with the tramways was getting on well except that in connection with this station.

Grand Rapids.—The *American Electrician* says that a company has been organised for the purpose of building an inter-urban electric railway from Grand Rapids, Mich., to Muskegon by way of Grand Haven. The line will be about 44 miles long, and the estimated cost is from $1,230,000 to $1,500,000. The track will be laid along private right of way parallel to the country highways the whole distance, and large cars provided with 200-H.P. equipments will be used.

Hawaii.—The report of the directors of the Hawaiian Tramways Company, Limited, for the year ended June 30th last, states that owing to local difficulties which have arisen, the contemplated change of motive power to electricity has been delayed, but the directors feel assured that the Government will encourage the company to carry out this conversion, which will be materially to the advantage of the citizens of Honolulu.

Huddersfield.—The Council has resolved to make application to the Board of Trade for sanction to the borrowing of £38,305 for tramway purposes for a period not exceeding 30 years.

Hyde.—At a meeting of the Stalybridge, Hyde, Mossley, and Dukinfield Electric Traction and Lighting Joint Committee, held at Stalybridge, it was resolved that application be made to Parliament for an Act to carry out a proposed joint electric traction and lighting scheme, and that the capital required for the purposes of the scheme be raised by calls in a similar manner to the capital raised under the Ashton-under-Lyne, Stalybridge, and Dukinfield (District) Waterworks Acts, each Corporation to contribute £100 towards the general expenses. In moving the adoption of the minutes at the last Council meeting, the chairman, Mr. Tinker, said that the Committee had gone very carefully into the details connected with the scheme, and that a deputation had been appointed to consider the advisability of applying for powers under a special Act. The Council ratified the proceedings.

Kingston.—At the meeting of the Town Council on Tuesday, the Tramways Committee reported the receipt of a letter from the London United Tramways, Limited, informing the Corporation that the company intended to apply to Parliament for powers to construct the following electric tramways affecting the borough:—

1. A tramway from Hammersmith Broadway, over Putney Bridge, Putney and Kingston Hills, through Kingston, and over the Thames to join a line already authorised at Hampton Wick.
2. A tramway from New Malden, through Morbiton, and joining No. 1 in London Road.
3. A tramway from the Kingston Gate of Richmond Park, through the borough and over Surbiton Hill to Tolworth.
4. A tramway joining No. 3 at the foot of Surbiton Hill, and passing through Surbiton to Esher.
5. A tramway joining No. 4 at Long Ditton, and passing through Thames Ditton to Hampton Court.
6. A tramway joining No. 4 at a point near Surbiton railway station, and proceeding along the Brighton Road to Hook.

In the construction of these lines the company's engineer, Mr. Clifton Robinson went on to say, "certain improvements, street widenings, &c.," would be involved, which he would be pleased to explain and discuss with the Committee before the date for making the Parliamentary deposits. After a long discussion the Council decided, by 16 votes to 7, to oppose the company.

The Lakes.—Mr. Chas. H. Dade, secretary, the British Electric Traction Company, Limited, has written to the *Daily Chronicle* as follows:—

While admitting that the spectacle of an electric railway could not be other than hideous if constructed on the "mangy hedgehog" principle, which your correspondent, Mr. R. P. Hughes, so graphically describes, I would point out that there are other and very much less objectionable methods of construction. As he considers my example from Rome beside the point, I would refer him to the overhead electric line which runs alongside the Niagara Rapids, and which has, without vulgarising the scenery, enabled an increased number of people to enjoy its beauties. I understand that the land upon which the line is constructed, where it runs upon Canadian territory, has been given by the Government for that purpose. Does this not indicate the larger and less selfish views taken abroad in giving the public facilities to see that which is beautiful?

Liverpool.—Colonel P. G. Von Dunop, R.E., officially inspected the Everton electric tramway route on behalf of the Board of Trade last week. The inspector found everything satisfactory, and the route will be opened at an early date. Before the commencement of the electric system there were 68 miles of lines over which horse cars ran, whilst with the Everton section a total of 60 miles of line have been converted or constructed for electric traction, and are either in use or ready for opening.

London Underground Electric Railways.—A report from New York was published the other day to the effect that an American syndicate, with the well-known promoter, Mr. Charles T. Yerkes, at its head, was negotiating for the construction of the proposed underground electric line linking Charing Cross with Camden Town, Kentish Town, and Hampstead, a connection which is undoubtedly very much wanted. The report was emphatically denied by a London newspaper, but the *Financial Times* has reason to believe that something of the kind is really in the wind, and that Mr. Yerkes' engineer is now actually in London in connection with these negotiations. This view is further corroborated by a correspondent of the *Times*, who states that all the preliminaries have been actually arranged, and that on the return of Mr. Yerkes to London next week the matter will be finally settled. The length of the line is about 6½ miles, and the total expenditure is calculated at between £3,000,000 and £4,000,000, while the necessary Parliamentary powers have been obtained by the Charing Cross, Euston and Hampstead Railway Company, which was incorporated in the summer of 1893.

Middlesex and Surrey.—It is stated in the daily press that Mr. Clifton Robinson, managing director and engineer of the London United Tramways, Limited, has given notice to the local authorities in Middlesex and Surrey that it is the company's intention to apply in the next session of Parliament for powers to construct additional extensions of their tramways, and to connect and work them as part of their system of electric tramways. The extensions will include 23 miles of lines in Surrey, 20 miles in Middlesex, and 20 in the county of London. The existing system, under this scheme, will be extended to St. Pancras, Marylebone, and Fulham, in the county of London; and across the Thames to Putney, and also northward to Willesden and Southall, and westward to Sunbury. The Surrey extensions will include a length of over four miles, connecting Putney with Richmond, *viâ* Upper Richmond Road and Sheen Road, and thence by a new street and new bridge across the Thames into Middlesex. Another line will leave the southern approach to Hammersmith Bridge and pass across Barnes Common;

and there will also be an extension from Kew Bridge to Richmond, *viâ* Richmond Road, Kew Road, and George Street. In Middlesex other lines will connect Isleworth with St. Margaret's, Hounslow, and Cranford, Brentford with Ealing, and Twickenham with Hanworth and Kempton Park. There is also an elaborate system of lines giving intercommunication between different parts of Kingston, Putney Hill, Surbiton, Tolworth, Hook, Long Ditton, Thames Ditton, Esher, and Hampton Court.

Newcastle-upon-Tyne.—Mr. Trotter was to hold a Board of Trade inquiry yesterday regarding the Corporation's application for sanction to borrow the requisite amounts to meet the payments under the following contracts:—

Higginbottom & Mannock for cranes, £2,349.
Vaughan & Dymond for steel work (power station), £10,312.
Swiney Bros. for steel work (car shed), £5,194 9s. 9d.
S. F. Davidson for erection of car sheds, £33,750.
The British Insulation Wire Company, Limited, for underground feeders, £7,700.
The British Thomson-Houston Company, Limited, for switchboard, £2,037.
The British Insulated Wire Company, trolley wires at schedule prices, estimated at £6,118.
Isaac Dixon & Co., galvanised steel car shed, £3,378.
Stephen Easten, erection of power station, £32,541.
Mather & Platt, Limited, pumping plant, £1,470.

New York.—The annual report of the Metropolitan Street Railway Company for the year ended June 30th is as follows:—

	1900.	1899.	Changes.
Miles operated	210	217	
Gross	$14,721,557	$13,158,630	Increase $1,562,920
Op. Ex.	7,104,607	6,408,711	Increase 695,896
Per cent.	48·26	48·70	Decrease ·44
Net	$7,616,941	$6,749,919	Increase $867,024
Fixed charges	4,608,768	4,477,757	Increase 131,011
Balance	$3,008,175	$2,272,162	Increase $736,013
Other increases	351,985	366,893	Decrease 14,928
Total increase	$3,360,160	$2,639,055	Increase $721,105
Div. paid	3,145,891	2,471,675	Increase 674,216
Surplus	$214,269	$167,980	Increase $46,889

The comparisons in the above tables are on identical track mileage for both years, and exclusive of the lately acquired Third Avenue system, which comprises 209 miles in actual service and between 35 and 40 miles of undeveloped franchises in that portion of the city lying beyond the Harlem River. The miles of track operated in 1899 and 1900 were the same, but while horse and electric power was used on the Amsterdam Avenue line during part of 1899, only electric power was used in 1900. This accounts in a measure for the decrease in the operating expenses. The average cost of operation per mile by electric power is 13 cents, whereas by horse-power it is 19·43 cents. —*Electrical World.*

Oldham.—The motormen and conductors in the employ of the Oldham, Ashton and Hyde Electric Tramways Company came out on strike on Saturday night in consequence of the manager discharging union employés and replacing them by non-unionists.

Rhyl.—After holding a public inquiry at Rhyl, the Light Railway Commissioners have decided to sanction the construction of an electric tramway from Prestatyn to the Marine Lake, Rhyl, a length of about seven miles. The route follows the sea coast. The capital of the concern is £7,500, and the Rhyl Council will supply energy for working the line. There was no opposition to the scheme, which is to be completed by next season.

Torquay.—A Committee of the Town Council has under consideration a scheme of electric traction embracing five miles of track, at an estimated cost of £50,000.

Walsall.—The electric tramcars were brought to a sudden standstill on Friday evening. The cause was due to some navvies, who were excavating near the generating station, breaking the main cable. This was, however, speedily repaired.

Wednesbury.—At a special meeting of the Town Council last week, the Mayor (Councillor Joynson) moved a resolution that notice be given to the South Staffordshire Tramways Company requiring them to sell to the Corporation as much of the tramway undertaking as lies within the borough of Wednesbury and as was authorised by "The Staffordshire Tramways Acts, 1879." Alderman Oldbury seconded the resolution, and pointed out that it did not mean the Corporation were going to assume the responsibility of working the trams. All they wished to do was to preserve their rights in the face of any arrangement that might eventually be made. The resolution was carried unanimously.

TELEGRAPH AND TELEPHONE NOTES.

Brazilian Telegraphs.—*Engineering* says that the business of the Western Telegraph Company, Limited, has increased to such an extent that a third cable between Rio de Janeiro and Pernambuco has become indispensable. It is to be laid forthwith.

The Emden and New York Cable.—A banquet was given at Berlin on Saturday evening by the German Atlantic Telegraph Company, to celebrate the successful laying of the first cable between Emden and New York. Herr von Podbielski, Secretary of State, proposed the first toast to "The Emperor and President M'Kinley," who, he said, fully acknowledged the great importance of direct cable communication between Germany and the United States.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
South American:—		
Pará-Maranham	March 1, 1900	
Ceará-Maranham	Feb. 20, 1900	
Direct Cable Pernambuco-Para	Sept. 19, 1900	
West Indies:—		
Mole St. Nicholas-Cape Haitien	March 6, 1900	
Latakia-Cyprus	June 20, 1899	
St. Louis (Senegal)-Bathurst	Aug. 25, 1900	
Tarifa-Tangier	Jan. 3, 1900	
Zanzibar-Mombassa	Sept. 29, 1900	
Landlines:—		
Chinese:—		
Tientsin-Pekin	June 12, 1900	
Pekin-Kalgan	June 14, 1900	
Kalgan-Maimatchin	June 30, 1900	
Tientsin, *viâ* Shanghai	June 16, 1900	
Tientsin-Niuchwang	June 18, 1900	
South American:—		
Communications with all offices of Columbia beyond Buenaventura	January 22, 1900	
Ecuador landlines	March 13, 1897	
Landlines south of Serena	July 30, 1900	
Communication "*viâ* Hanekino" interrupted on Persian territory	Feb. 24, 1900	

The Telephone in Australia.—Australia is rapidly pushing ahead in the matter of telephone extension—much more vigorously, indeed, says the *Financial Times*, than the Mother Country. Some time ago the Governments of New South Wales, Victoria, South Australia and Queensland conferred together on the advisability of connecting together their respective capitals, but though the advisability was conceded, the cost was declared to be prohibitive. It was finally agreed that for a start, wires should be laid only between Brisbane, Sydney and Melbourne, and the requisite outlay was put at £42,000. The Postmaster-General of Victoria is now calling for estimates for the construction of the line between Melbourne and Sydney, the original expense of which was computed at £24,000, of which £8,000 was to be borne by Victoria, and £16,000 by New South Wales. Our contemporary adds:— "The suggested charge for using the wire the whole distance is 5s. for five minutes. The reason why the more extensive intercolonial proposal was dropped was the slight possibility of earning a reproductive revenue, but experience shows that if through rates are moderate local income will make up for any deficiency of income at terminals. This argument, however, is most effective when applied to a fairly densely populated country, which it must be admitted Australia is not. But that is a defect time is fast remedying, and no doubt the principal reason for continuing the Melbourne-Brisbane line to Adelaide, and even to Perth, when the first section is laid, will be the very existence of that section."

Wireless Telegraphy.—The Rev. J. M. Bacon telegraphs to the *Times* on 21st inst.:—"As conducting the wireless telegraphy from the balloon last evening at the instance of the committee of the garden party of the British Association, at Bradford, I can report that the signalling was a complete success, and all credit is due to Mr. Nevil Maskelyne for the admirable working of his special apparatus. We took a lofty flight, and for 90 minutes' space sailed away over Wakefield, Barnsley, and so on for Sheffield, attaining an altitude of almost a mile, at which height it would certainly be impossible for a balloon to be hit in warfare save by a blundering shot. We were in constant communication with our base, and could have minutely described every feature visible over the wide area below, and practically every feature was revealed. We looked down every breathing hole of the hidden mines over which we passed, searched the recesses of the woods, and could have counted every furnace for 10 miles round, and all the while we were receiving constant assurance from distant Bradford that the line was clear. The experiment terminated with the life of the balloon only."

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—September 29th. The Electric Lighting Committee wants tenders for two 200-kw. direct coupled continuous current generators, and one 120-kw. balancing set; one 420-kw. direct coupled generating set. All Willans engines. See "Official Notices" August 24th.

Aberdeen.—October 17th. The Tramways Committee wants tenders for 25 electric tramcars, and electrical equipments for six horse cars. See "Official Notices" September 21st.

Belgium.—October 10th. Tenders are being invited until October 10th by the Belgian State Railway authorities at La Bourse, Brussels, for the supply of 20,000 porcelain insulators for telegraph lines, 65,000 ditto for telephone lines, 15 tons of galvanised iron wire 3 mm. diameter, and 60 tons ditto 4 mm. diameter.

Bermondsey.—October 15th. The Vestry wants tenders for steam and other piping, feed pumps, tank and ironwork; also steam dynamos, battery charging motor booster and balancer. See "Official Notices" to-day.

Birkenhead.—October 2nd. The Corporation wants tenders for feeder mains. See "Official Notices." September 21st.

Bootle.—October 13th. The Corporation wants tenders for a steam dynamo. See "Official Notices" to-day.

Bradford.—October 9th. The Corporation wants tenders for an engine and dynamo and switchboard apparatus, &c., for its destructor works. See "Official Notices" September 21st.

Bray.—October 4th. The District Council wants tenders for electrical supplies for the electric light works for 12 months. See "Official Notices" September 21st.

Brighton.—October 1st. The Corporation invites tenders for electric motor cars, steel rails, fishplates, &c. See "Official Notices" September 14th.

Budapest.—October 15th. The Hungarian Minister of Commerce is prepared to receive tenders for the installation of two telephone exchanges, local and interurban, complete in all respects. See "Official Notices" August 3rd.

Bulgaria.—October 15th. The municipal authorities of Varna are inviting tenders until October 15th for the concession for the electric lighting of the town during a period of 40 years

Bulgaria.—October 22nd. Tenders are invited by the Municipality of Philippopolis for a concession for electric lighting and a tramway in that town.

Cuba.—October 26th. The municipality of Cienfuegos is inviting tenders for a service of public electric lighting for the town. All inquiries and tenders to be sent to the Secretary's Office in Cienfuegos, Cuba.

Dublin.—October 4th. The Electric Lighting Committee wants tenders for the supply and laying of mains and accessories. See "Official Notices" August 31st.

Eastbourne.—October 4th. The Corporation wants tenders for a water-tube boiler and fittings, 400-kw. steam alternator and switchboard. See "Official Notices" September 7th.

Glasgow.—September 28th. The Corporation are prepared to receive tenders for the supply and fitting up of the power station piping required at Pinkston. Specifications, &c., on application to Mr John Young, general manager, 88, Renfield Street, Glasgow. A bank draft for five guineas, payable to the General Manager, must accompany each application for specifications.

Grimsby.—October 6th. The Corporation wants tenders for wiring the free library. See "Official Notices" September 21st.

Grimsby.—October 6th. The Corporation wants tenders for the wiring of the Free Library.

Hackney.—October 3rd. The Electric Lighting Committee wants tenders for electricity supply mains. See "Official Notices" September 14th.

Hoylake and West Kirby.—October 4th. The District Council wants "free wiring" offers. See "Official Notices" September 21st.

Ilford.—October 8th. The Council wants tenders for direct current meters and cut-outs. See "Official Notices" September 21st.

Maidstone.—October 16th. The Corporation wants tenders for surface condenser and feed pumps. See "Official Notices" to-day.

Manchester.—October 1st. The Tramways Committee wants tenders for the supply of cast-iron bases for tramway poles. See "Official Notices" September 21st.

Salford.—October 2nd. The Cleansing Committee of the Corporation wants tenders for a two or three-cell refuse destructor. Also for a six-cell destructor on the forced or accelerated draught principle, together with necessary boilers, &c. See two "Official Notices" August 31st.

Sheffield.—October 6th. The Corporation wants tenders for two two-phase steam alternators and exciters of 600 kw. each, and the alteration of present single-phase plant to two-phase plant. See "Official Notices" September 14th.

Spain.—October 11th. The *Madrid Gazette* publishes a notification of the conditions on which a contract for the electric lighting of the town of Azuaga will be awarded. Tenders will be received by the municipality up to 11th prox., the upset price being 9,000 pesetas annually for electric lights of 3,000 c.p., distributed in incandescent lamps of 10 and 16 c.p.

Suffolk.—October 5th. The Visiting Committee of the County Lunatic Asylum wants tenders for the wiring and fitting of the County Asylum at Melton for electric lighting. See "Official Notices" September 14th.

Sunderland.—October 15th. The Corporation wants tenders for 24 car bodies, trucks, and electrical equipments. See "Official Notices" to-day.

Swansea.—October 10th. The Corporation wants tenders for cast-iron arc and incandescent lamp standards, arc lamps, automatic switches and other fittings. See "Official Notices" to-day.

Warrington.—The Corporation wants tenders for the installation of electric light mains and fittings into the electric station and central sanitary depôt. See "Official Notices" to-day

Whitehaven.—October 13th. Tenders are wanted for the supply and erection of a switchboard at their electric lighting station. See "Official Notices" September 14th.

CLOSED.

Ayr.—The Corporation has placed the contract for the two 200-kw. traction and lighting generators coupled to Belliss engines, with Messrs. D. Bruce Peebles & Co.

Belgium.—Seven firms competed for the contract for the establishment and working of a central electric lighting station at St. Gilles-les-Bruxelles, the lowest being that of Messrs. von Mulmann & Forkel, of Brussels.

Bristol.—The Libraries Committee has accepted the tender of Messrs. Read & Jenkins, for the installation of the electric light at the new library in Bristol North.

Germany.—The Union Electricitäts Gesellschaft of Berlin, has secured a contract to convert the tramways in the town of Metz to electric traction.

Glasgow.—Among tenders recently accepted by the Corporation are the following:—150 two-ampere electricity meters, at £3 10s. each, Messrs. Chamberlain & Hookham; one half-mile of ·5 and one half-mile of ·25 lead sheathed cable, at £335 and £176 respectively; five miles of 3-20 telephone wires, at £275; and one mile of ·15 treble concentric cables at £651, Callender's Cable and Construction Co., Limited; 100 tons of 30-inch cast-iron water pipes and special castings required for the new Govan Street Bridge, £917 3s., Messrs. Macfarlane, Strang & Co., Limited; Mr. William Baird, supplying and fitting up bearers underneath these pipes, 30s. each bearer; 31 tons of steel girders, &c., required in connection with two bridges across the Monkland Canal at Castle Street, at £417 18s., the Brandon Bridge Building Company, Limited; 500 tons of cast-iron pipes, £3,617 15s., Messrs. Robert M'Laren & Co.

Greenock.—The Police Board have now considered the offers for the supply and erection of traction plant, and have accepted the tender of the India-Rubber, Gutta-Percha and Telegraph Works Company, for Contract No. 6, and that of Messrs. Babcock & Wilcox for Contract No. 5.

Witney.—The Hart Accumulator Company, Limited, have secured the contract for the supply of storage batteries required for the Witney electric lighting.

FORTHCOMING EVENT.

Thursday, October 4th.—At 8 p.m. Civil and Mechanical Engineers' Society. Meeting to be held at the Hotel Victoria, Northumberland Avenue, S.W., when the president (Prof. R. H. Smith, Wh.Sc., A.M.I.C.E., M.I.M.E., M.I.E.E.), will deliver his address on "Training to Keep Ahead in the World's Competition."

WATER-POWER GOVERNING.

Mr. Elmer F. Cassel is responsible for the statement in the *Engineering Magazine* that the total power in the United States of all kinds is 4 million h.p. We had always thought that that of Great Britain was 7 million, and that the United States had gone past this number. Yet the available water-power of the United States is 200 millions of horse-power, and Italy has 5 million. Canada has as much as the United States. Norway and Sweden have 50 million, and most other countries have large water supplies.

Only recently, however, has much been done to develop water-power, especially of the high head type, and it is to the carrying power of electricity that water-power owes its best development. Why, it is asked, has it not been more used? The answer is, the difficulty of controlling it. This may be so, but our own impression is that frost has more to do with it than want of governing capacity. High head water, states the author, is only applied where load variation is slight, or speed variation of no consequence.

A steam engine is self-contained, and governs under the widest range of load at which it can turn round at its full speed, and when water-power is equally reliable, it will be much more widely used. Present practice in water-power governing is denounced as an attempt to accomplish the impossible. Variation of supply naturally suggests itself, yet even with low heads this could not be done with sufficient promptness to be satisfactory. The difficulty is enhanced with high heads, and the trouble is, of course, inertia of the flowing water in the supply pipe. This, if arrested, would speedily wreck the pipe. In some cases the trouble has been got over by stand pipes to receive the stream when shut off the turbine, and relief valves have been employed.

Now, as the flow of water cannot easily be stopped, the question arises whether it ought to be attempted. Why not govern without changing the flow, especially if there is no object in conserving the flow? In the majority of cases it matters very little how much goes to waste. Thus the stream of water may be moved off the wheel by the governor. This would be particularly suitable in the case of the Pelton wheel, and to do this the governor must obviously be only of the relay type. It must actuate a powerful nozzle-deflecting mechanism. But such governors are not very good after all. They merely limit the range of speed, but do not control it. They are assisted by the use of heavy fly-wheels. The necessary conditions are:—

1. An entire avoidance of shock in the supply pipe.
2. The governor must be powerful enough in itself to perform the governing duty.
3. It must be reliable.
4. It must be inexpensive.

The author says an impact wheel can be devised such that its buckets can be moved out of the line of impact with very small power application. The centrifugal force developed in the wheel itself must be used for this purpose. A construction that recommends itself is a division of the wheel along the centre lines of the buckets into two sections, so arranged that any increase in speed will cause the two halves to separate and allow the jets to pass wholly or in part between the buckets in place of impinging upon them. Thus governing will be instantaneous, the action of the wheel automatic, and the wheel self-contained. This device permits, if desired, of the employment of any of the well-known means of *slowly* shutting off the head of water without danger to the line. This resembles the well-known supplementary governor of the steam engine, which brings the engine to its exact normal speed at all points of cut-off. The device has been demonstrated by eight months' use, and it seems to us that the idea is perfectly sound.

The author looks to the distribution of power from central pumping plants without electrical conversion. Such power is easy to instal; the cost of a jet turbine is small. But it is natural water-power that demands attention, and can only be utilised by means of electricity, and in countries of severe winters water-power is a precarious possession that too often demands a large outlay on steam plant, so that the only saving is that of fuel in summer time, and the first cost of double plant is often prohibitive.

NOTES.

Meters.—Has anyone ever heard of a gas meter which failed to keep a correct record? If so, we hope he will *not* write and inform us. Like some other things made to measure, gas meters have been known to be very accommodating in regard to figures. Unkind things have also been said about electricity meters, that when all your lights are "on" you consume no energy, and when none are "on" you are consuming energy as fast as your meter can record. But whatever may be thought about electricity meters, it cannot be said that they are so old in sin and steeped in iniquity as their rivals. Though they do not always measure accurately, gas meters sometimes establish a record; to wit, the Rotherhithe Vestry has a meter which is now proved to have for the past 18 years registered only one-tenth of the quantity of gas consumed, whereat the South Metropolitan Gas Company is, of course, very wroth, and may yet set the law in motion to recover £2,927 14s. 9d. (how precise) for the nine-tenths which went amissing, instead of impressing the gas meter. The company's secretary has written asking for a cheque, but its meter should have kept a better check on the Vestry. The strange thing is that the wickedness of the meter seems never to have been suspected until now!

Appointments Vacant.—An assistant engineer is wanted by the Fleetwood and District Electric Light and Power Syndicate. See "Official Notices."

The Manchester Tramways Committee wants a lady superintendent for its ticket and cash counting department. See "Official Notices" to-day.

An electrical engineer is wanted by the Canterbury Corporation at £78 per annum. See "Official Notices."

Personal.—The New York *Electrical World* says that Mr. H. M. Sayers, power engineer to the British Electric Traction Company, Limited, has been visiting some of the large electrical undertakings in America, accompanied by members of the staff. "He and his colleagues have visited several of the Eastern cities, and met with an extremely cordial reception. They were very much gratified to find that not only were their requests for information generously answered, but no efforts were spared for their comfort, or to let them see whatever was worth while in each place. They have just returned home, after a most enjoyable and instructive tour."

We are pleased to be able to record that Mr. Fred. Bathurst, who has for some time past been somewhat seriously indisposed, has now quite recovered. His friends will be glad to learn that he is now back again among his interior conduits, looking considerably improved for the change.

When giving the names of the applicants for the post of electrical engineer to the Swansea Corporation, we mentioned that Mr. Pringle was resident engineer of the Brush Wandsworth station. We are asked to correct this, as he is resident engineer for the Brush Company contracting at the County of London Co's Wandsworth station.

We understand that Mr. Wm. Stevenson has been appointed to succeed Mr. A. S. Dunn as electrical engineer and telegraph superintendent of the Caledonian Railway. Mr. Stevenson has been assistant to Mr. Dunn for a considerable number of years.

The 1900-1901 Session.—Among papers, &c., which have been arranged for reading before the Civil and Mechanical Engineers' Society during the next session are the following:—

October 4th, 1900.—Prof. R. H. Smith (President) on "Training to Keep Ahead in the World's Competition."
January 3rd, 1901.—Mr. W. B. Esson on "The Case for Electric Power Distribution."
April 4th.—Mr. A. Hanssen on "The Proportions of Cylinders for Multiple Expansion Engines."
May 2nd.—Mr. A. H. Allen on "The Storage of Electricity."

The meetings are to be held at the Hôtel Victoria, Northumberland Avenue, S.W., on Thursday evenings, at 8 p.m.

The Viagraph.—This interesting instrument was described by Mr. J. Brown before Section G at the B.A. meeting. It is an instrument for testing the unevenness of road surfaces, and ought to prove of great use to engineers engaged in drawing up tramway schemes. It is practically a straight-edge applied to the surface of the road along which it is drawn in making a test, with an indicating part attached. A wheel, which runs on the road surface and rises or falls over its irregularities actuates a pencil, making a profile of the road surface on a paper strip to an approximate scale. The instrument also indicates the total added depths of all ruts or depressions over which it passes, thus giving a coefficient of unevenness for each road. At the end of 88 yards a bell is rung automatically. The operator then stops the instrument and takes off the diagram.

Marriages.—On 19th inst., Mr. W. J. T. Duncan, of the firm of Foxcroft & Duncan, of Dalston, N.E., was married at Perth to Dorothea Watt, second daughter of Mr. John Stewart, of that city.

On 22nd ult., at Blackpool, Mr. Frederick Stewart, of the Blackpool and Fleetwood Tramroad Company, was married to Sarah Agnes, daughter of R. B. Dawes, Esq., of Ulverston. The employés presented Mr. Stewart with a pair of bronzes and a marble clock.

American Street Railway Association.—The annual meeting of this association will be held at Kansas City, Mo., October 16th, 17th, 18th and 19th. Among the papers to be read are "Double Truck Cars; How to Equip Them to Obtain Maximum Efficiency Under Varying Conditions"; "Comparisons of the Various Systems of Electrical Distribution for Street Railways"; "Consolidation of Street Railways and Its Effect upon the Public"; "The Store Room and Store Room Accounts"; "Painting, Repainting and Maintenance of Car Bodies." There will be a large exhibition of street railway supplies.

Propagation of Electric Waves Along Parallel Wires.—In a brief note contributed to the proceedings of Section A of the British Association at Bradford, Mr. W. B. Morton referred to a very complete investigation of this problem, published by G. Mie in the *Annalen der Physik* for June, 1900. Mie found expressions for the wave-length and damping of the oscillations, involving a series of ascending powers of the ratio of radius of wires to distance apart. The object of Mr. Morton's note is to point out that the approximate solution, in which the square of this ratio is neglected, can be very easily obtained from the known solution for a single wire, as worked out by Prof. J. J. Thomson and by Sommerfeld. The formula for the damping agrees with that given by Heaviside's simple theory when Lord Rayleigh's high-frequency values are used for the resistance and inductance. Attention is called to an error in the formula for the K_0 function in the work of Thomson, Sommerfeld, and Mie, arising, probably, from an erratum in Heine's "Kugelfunctionen." It affects the numerical values worked out in Sommerfeld and Mie's papers.

Transformer Core Deterioration.—In an editorial note in the September issue of the *American Electrician* it is stated that the "ageing" of transformer cores has become a familiar phenomenon, and in many cases has caused a serious increase in the fixed losses of alternating current stations. The very latest types of transformer contain iron that has a very low ageing coefficient, but there are hundreds of stations operating transformers that were built before the peculiar characteristic referred to had received proper attention. The writer says that a simple remedy for such stations is to systematically take in its transformers, a few at a time, dismantle them, and anneal the core iron. There have been cases where this policy has resulted in a yearly saving of 100 to 200 times the cost of annealing.

The Thermal Storage Tank.—We hear from time to time of the thermal storage tank and its capabilities. The idea underlying the thermal storage system is the antithesis of the water-tube boiler idea, namely, the provision of a very large amount of water to serve as a reserve of heat in order to allow of a small boiler taking in a fairly continuous supply of heat while performing a very variable duty. The idea is not altogether sound or of universal application. In every boiler plant it is practically impossible to reduce the waste gases to an economically low temperature without a flue feed heater. In a thermal storage system the storage tanks are heated up to the boiler temperature, and when the maximum load period comes on this hot water is used to feed the boiler, so that the furnace only furnishes latent heat and produces steam at the same temperature as the storage tank. Obviously during such a period there can be little or no use made of the flue feed heater, and the waste gases are rejected at an excessive temperature. It does not seem to us that the thermal storage system can furnish an economy of serious value unless the boiler and tanks can be worked up to a temperature and pressure considerably in excess of the working pressure of the engines to be driven. In this way only can there be any serious amount of heat stored and use still made of the flue feed heater during the periods when the thermal tanks are being drawn upon. It is true that the thermal tank can be made very much more cheaply than a boiler. It may be simply a plain cylinder with hemispherical ends, or if room be worth it, with flat ends and gusset stays. In any case there must also be longitudinal bolt stays. But the shell plates must, for any diameter of tank, be as thick as the plates of a Lancashire boiler of equal diameter. It is by no means unknown in practice that an economiser will deliver its feed water at the same temperature as the boiler, which is all that thermal storage can do. In a recent paper by Mr. C. N. Russell, of Shoreditch, the use of hot feed is referred to much as if hot feed were a new discovery with all its benefits, and it appears as though some such idea dominated those who advocated the system. A fair-sized Lancashire boiler will evaporate 6,000 lbs. of water per hour. In 18 hours, to use the period named by Mr. Russell for storing heat, such a boiler would approximately generate 108 million heat units, and assuming the tanks to be filled with water at 100°, and to be raised to 350°, about 43,000 gallons would be required. This is just about the capacity of five egg-ended tanks 30 feet long and 8 feet diameter. Thus, to follow out the thermal system requires enormous storage capacity and great expense, and it seems to us very doubtful whether the system can be made economical unless provision is also made, as stated above, for very much higher pressure of storage than that at which power is to be developed. One virtue the thermal tank does possess. It forms a fine sludge depository, and prevents much scale-forming matter being passed on to the boilers.

Wireless Telegraphy.—M. Willot, Chief Inspector of French Telegraphs, is stated by the daily press (with its usual glibness) to have made a discovery affecting wireless telegraphy "which will entirely revolutionise" that means of communication. What M. Willot has actually stated we are not in a position to be able to say, but if, as reported, he has argued that the limit range could not, on account of the rotundity of the earth, exceed more than 40 miles or thereabouts, he must be lamentably ignorant of the way in which lines of force are transmitted. M. Willot, we are told, has come to the conclusion that the earth, and not the air, really does duty as the transmitting medium, and that by boring shafts at two stations between which it is desired to communicate, until geological beds are reached which have the same electric level—that is, where the earth's electricity has the same tension—then wireless communication can be effected between the two shafts, and further, that at other levels separate communications can be carried on.

Double-Current Generators for Electric Railway Service.—The Massachusetts Electric Companies, which have consolidated 38 railroads and two lighting systems in Eastern Massachusetts, propose to reduce the cost of operation of their extensive system by centralizing their generating stations. We gather from the *Street Railway Journal*, that the first move in this direction will be on that part of their system in and around Salem, and will be made by the addition of polyphase apparatus to transmit power from the present Salem direct-current station to neighbouring towns. Sub-stations will be located in Wakefield, Essex and Gloucester. Two 800-KW. double-current generators will be installed at Salem, direct coupled to engines, making probably the first instance of direct-coupled double-current machines for railway service in this country. These machnes may be run in parallel with three 300-KW. direct-current machines now in service at this point, although there is some doubt as to the advisability of so running them on account of the disturbing effects of wattless currents on the field strength of the double-current machines. Since this disturbing effect will not be felt on the direct-current machines, it may affect the division of the direct-current load between the two classes of machines. If this is so to a serious extent, it may be necessary to run the double-current machines on a separate set of buses and a separate load from the direct-current machines. The Massachusetts Electric Companies own the Lowell and Suburban road with its pioneer polyphase transmisson line from Lowell to Nashua. The new transmission will be carried out in the same manner to a large extent.

War on the Jerry Wirer.—As one way of helping to weed out jerry wiremen it was proposed by Mr. Mountain at this year's convention of the Municipal Electrical Association, that electric wiremen should be registered. We now read in a Chicago electrical journal that a Bill is to be presented to the Indiana Legislature, "the provisions of which stipulate that persons installing electric wires shall be licensed before they can engage in this work; the object of the Bill is to guard against the improper wiring of buildings."

Correction.—We regret that in our account of the Smelting Corporation's works at Ellesmere Port we omitted to mention that the mechanical stokers and coal chutes were supplied and erected by the Underfeed Stoker Company, Limited.

Spiders' Webs and Overhead Wires.—An American exchange says that the Government of the Argentine Republic has determined to lay an underground cable 150 miles long between Buenos Aires and Rosario in order to obtain reliable telegraphic service, which is impossible with overhead wires. Small spiders spin long webs which settle on the wires in such numbers as to form serious leaks as soon as they are moistened by dew or rain, the result being intolerable interruptions of the service.

SUPPLY STATION ACCOUNTS.

Coventry Corporation Electricity Accounts.

The undertaking of the Coventry Corporation is one of those which has as yet not reached the stage of paying all the financial charges which have to be met by a municipal department. The accounts presented below cover different periods. Under the head of 1898 the results of 15 months' working are given, while under 1899 the usual twelve-monthly period up to March of this year is taken. Mr. Ram is approaching the turning point, and has had to carry out recently some fairly extensive alterations and repairs, now practically completed. The extensions ought to enable the business to show still more encouraging results; as it is an increase of revenue of about £600 on a total of roughly £3,600 has been obtained, with extra expenditure amounting to only £130, leaving an increase in gross profit of £460, or considerably more than double the gross profit in 1898.

GENERAL STATEMENT.

	1898. 15 months' working.	1899. 12 months' working.	Increase.
Total capital expenditure ...	£45,660	**£63,565**	£17,905
Number of units sold	149,547	**229,607**	80,060
Maximum load in KW.	156	**242**	86
No. of 30-watt lamps connected ...	10,666	**17,806**	7,140
Gross revenue	£3,599	**£4,193**	£594
Gross expenditure	£3,292	**£3,422**	£130
Gross profit	£307	**£771**	£464
Average price per unit sold ...	5·65d.	**4·29d.**	−1·36d.

The receipts per unit have fallen by the large figure of 1·4d., and this reduction should have a stimulating effect upon the output. Although over 4¼d. is a rather high average, it is justified by the small output of under a quarter of a million units.

REVENUE STATEMENT.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Sale of energy, &c.	£3,520	5·65d.	**£4,110**	4·29d.	−1·36d.
Meter rents, &c...	77	13d.	**83**	·09d.	−·04d.
Sale of materials, &c.	2	·00d.	...	..	...
Sundry fees	...	...	...	...	...
Gross revenue ...	£3,599	5·78d.	**£4,193**	4·38d.	−1·40d.

The most satisfactory feature of the accounts is the cost sheet, showing as it does reductions under each head with the exceptions of "Fuel" and "Rent, rates, and taxes." The former has risen by nearly $\frac{1}{10}$d., as might be expected, while the gross value of the latter has nearly doubled, and the engineer has little or no control over the assessment, but the increases are trivial compared with the reduction on works cost of 1·3d. and on total cost of nearly 1¾d. per unit. Economical management is shown clearly by the reductions in the gross values under "Oil, waste," "Wages," and "Repairs." The changes are very marked in these and in "Management salaries." Yet we believe that they have principally been effected by the improvements carried out in the technical details of the generating and distribution systems.

COST OF PRODUCTION.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal	£534	·86d.	£914	**·95d.**	+ ·09d.
Oil, waste, water and engine room stores.	279	·45d.	278	**·29d.**	− ·16d.
Salaries and wages incurred in generation and distribution.	1,188	1·90d.	997	**1·04d.**	− ·86d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	446	·72d.	332	**·35d.**	− ·37d.
Works costs ...	£2,447	3·93d.	£2,521	**2·63d.**	−1·30d.
Rent, rates and taxes ..	139	·22d.	265	**·28d.**	+ ·06d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	490	·79d.	397	**·42d.**	− ·37d.
Establishment charges, stationery and printing, law charges and insurance	189	·31d.	219	**·23d.**	− ·08d.
Other expenses	27	·04d.	20	**·02d.**	− ·02d.
Total costs ...	£3,292	5·29d.	£3,422	**3·58d.**	−1·71d.

The financial results by themselves might be regarded as somewhat disappointing. Thus, notwithstanding the increase in gross profit by £464, the net loss, or deficit, has gone up by £116 owing to the addition of £579 on the financial charges. Coventry is one of the systems which can only be saved by a materially increased output, and every endeavour is, we understand, being made to attain this.

PROFIT STATEMENT.

	1898.	1899.
Interest on loans and bank charges	£1,153	£1,732
Sinking fund for repayment	783	783
Net profit carried to rates	−1,629	−1,745
Gross profit	£307	£771

The deficit in 1898 was equivalent to a loss of 2·6d. per unit, and in 1899 to 1·8d. per unit.

CITY NOTES.

Willans & Robinson, Limited.

THE report of the directors for the half-year ended June 30th, to be submitted at the ordinary meeting, to be held at Victoria Works, Rugby, on Wednesday, October 3rd, reads:—

After writing off depreciation from plant, patents, &c., the sum of £5,680 19s. 4d and paying interest upon debenture stock, the balance to the credit of profit and loss account at the end of the half-year (including £5,212 1s. 1d. brought forward) is £31,399 8s. 11d. Out of this the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares and 10 per cent. per annum upon the ordinary shares, together amounting to £14,923 17s. 10d. The amount payable to the original directors, in accordance with the articles of association, being £4,218 8s. 2d., the balance available is £12,257 2s. 11d. From this the directors propose to carry £2,000 to the debenture redemption fund and £3,500 to the reserve fund, leaving £6,657 2s. 11d. to be carried forward. The balance of the capital remaining to be issued under the authority of the extraordinary resolution passed on March 29th, 1899, viz., 10,000 preference and 10,000 ordinary shares, was allotted to the shareholders in June last. The allotments were taken up as regards 8,788 preference and 9,425 ordinary shares, and the balance was so greatly over-applied for by the shareholders that it could only be allotted in about the proportion of one preference share for every 10 applied for, and of one ordinary share for every 50 applied for. The large engine, capable of working up to 3,000 I.H.P., exhibited by the company at Paris, in conjunction with a dynamo by Messrs. Siemens Bros. & Co., Limited, has been awarded a Grand Prix, another similar award being made for the dynamo. The balance upon the share premiums accounts stood at the commencement of the half-year at £29,656 2s. Of this, in accordance with the intentions expressed at previous meetings, £5,000 has been applied to a special writing down of the company's property at Thames Ditton, and £20,000 has been transferred to the reserve fund. The balance, £4,656 2s., has now been brought up again to £21,493 2s. by payments under the first instalment of the premiums upon the last issue (1900). As one of the principal objects of both this and the preceding issues of capital was to enable the company to make engines of large size, the directors are of opinion that the expenses incurred at the Paris Exhibition, which has served to introduce the company's new work to the public, may fairly be defrayed out of the premiums account. Owing partly to difficulties in obtaining dynamos from the makers, and partly to other causes for which the company is not responsible, an unusually large value of completed, or nearly completed, engines (all on order) remained in the accounts at the end of the half-year under the head of "unfinished work." Had it been possible to deliver and invoice these engines in the half-year a larger amount of profit would have been brought into the accounts.

Mersey Railway Company.

MR. JAMES FALCONER, who presided at the half-yearly meeting of this company, held in London on Tuesday, said that the most important work which the directors had had to deal with since the last general meeting had been the promotion of the Act passed by Parliament in the last session for enabling the company to work the railway by electricity. The Act also embraced a power to extend the time for paying off the redeemable first debenture stock, which was the first charge on the company's revenues, and which would have fallen due last month but for this extension. The Bill further embraced a scheme for rearranging the finances of the company, and for the appointment of a joint committee, by agreement with the Wirral Railway Company, for enabling the two companies to have a joint system of electric traction. The *Times* reports the meeting as follows:—"According to the best advice which the directors had been able to obtain—and the advice was unanimous—the result of adopting electric traction would be not only to free the tunnel from the fumes which were so objectionable to passengers, but also to cheapen the cost of working, while greatly increasing the service of trains. The change would therefore be greatly in favour of the company, and he ventured to think that with the passing of the Act they had started upon a new career. The difficulties against which they had had to contend with steam traction, and the want of success which had consequently met the company, would not be experienced with electric traction, and their past was no indication whatever of what their future might be. This was the opinion on which the directors went in promoting the Bill, and it had been strikingly confirmed by the result of the opening of the Central London Railway—an electric line working under conditions not nearly so favourable as in the case of this company's line. The Mersey Company, for instance, had a full-sized railway tunnel of the ordinary type, and they had complete liberty as regarded the construction of their carriages and the electrical plant with which to haul them. The Central London Railway, by the facilities and convenience it offered, was making a traffic of its own, and this was a very encouraging feature as regarded their own line. One thing was certain from the results attending the working of the

Central London Railway, namely, that the Mersey Company would be able, by the adoption of electric traction, greatly to increase the number of persons who travelled by their line. In regard to the future, the directors proposed, as soon as possible, and in the best way they could, to arrange for having the line worked by electricity. The first point which the new board would have to deal with would be to ascertain whether, advantageously to the company, they could enter into the arrangement he had alluded to with the Wirral Company; and their next important duty would be to arrange for the necessary capital, and to conclude contracts for the construction of the electrical works. In answer to questions, the chairman stated that if a joint scheme were arranged with the Wirral Company for working the two concerns by electric traction, the cost involved was estimated, roughly, at £500,000; that was the amount of the borrowing powers provided for. If they did not come to terms with the Wirral Company and had to raise the money on their own account, the cost was estimated at about £300,000."

Rockhampton Gas and Coke Company, Limited.—The directors' report for the half-year ended June 30th, 1900, shows that while the consumption of gas still continues to steadily increase (the gross revenue from that source being over 22 per cent. more than that for the corresponding period of last year), the electrical operations still show a slight loss.

Stock Exchange Notice.—Application has been made to the committee to allow the following securities to be quoted in the Official List:—Aron Electricity Meter Company, Limited, 125,000 ordinary shares of £1 each, fully paid, Nos. 1 to 125,000.

Evered & Co., Limited.—The directors have decided to pay an interim dividend at the rate of 7½ per cent. per annum for the half-year ended June 30th last.

Globe Telegraph and Trust Company.—The directors announce a quarterly dividend of 1s. 9d. per share on the ordinary shares.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending September 22nd, 1900, were £1,044 19s. 3d.; receipts for corresponding period, 1899, £883 8s. 11d.; aggregate for half-year to date, £16,895 0s. 6d.; aggregate corresponding period of last half-year, £16,767 18s. 2d.

The Bristol Tramways and Carriage Company.—The receipts for the week ending September 21st, 1900, were £3,554 16s. 2d.; corresponding period, 1899, £3,402 0s. 4d.; increase, £134 15s. 10d.

The Central London Railway.—The receipts for the week ending September 22nd, 1900, were £4,191; previous week, £4,883; increase, £58. Total receipts to September 22nd, 1900 (8 weeks), £37,199. Miles open, 6.

The City and South London Railway Company.—The receipts for the week ending September 23rd, 1900, £1,519; September 24th, 1899, £914; increase, £605. Total receipts for half-year, 1900, to date, £18,047; corresponding period, 1899, £11,121; increase, £6,8.6. Miles open, 1900, 4½; 1899, 3¾.

The Cork Electric Tramways and Lighting Company.—The receipts for the week ending Thursday, September 20th, 1900, were £477 9s. 0d.; corresponding week last year, £437 15s. 3d.; increase, £39 13s. 9d. Total to September 20th, 1900, £15,723 6s. 10d.; corresponding period last year, £14,453 0s. 2d.; increase, £1,270 6s. 8d.

The Dover Corporation Tramways.—The receipts for the week ending September 22nd, 1900, were £285 17s. 10d.; September 23nd, 1899, £279 0s. 3d.; increase, £6 17s. 7d. Total receipts to date, 1900, £7,978 2s. 4½d.; corresponding period, 1899, £7,552 1s. 0d.; increase, £316 1s. 4½d. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 5,095; 1899, 5,280. Number of cars, 1900, 11; 1899, 11.

The Dublin and Lucan Electric Railway.—The receipts for the week ending September 22nd, 1900, were—Passengers, parcels, &c., £108 5s. 5d.; corresponding week last year, £93 13s. 10d. Total receipts to date, 1900 (12 weeks), £1,401; corresponding period, 1899, £1,140; increase, £261. Miles open, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, September 21st, 1900, were as follows:—D. U. T. Co., horse cars, £29 8s. 7d.; ditto, electric cars, £3,627 8s. 10d.; D. S. D. Co., electric cars, £999 19s. 0d.; total, £4,666 16s. 5d; corresponding week last year—D. U. T. Co., horse cars, £1,143 0s. 11d.; ditto, electric cars, £2,008 16s. 2d.; D. S. D. Co., electric cars, £848 18s. 11d.; total, £4,000 16s. 0d.; increase, £666 0s. 5d.; aggregate to date, £60,600 18s. 9d.; aggregate to date last year, £54,928 17s. 10d.; increase to date, £5,672 0s. 11d. The mileage worked is 43 miles electrically, 1 mile by horses, as against 24 miles electrically, 20 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending September 23rd, 1900, were £1,789; corresponding week last year, £1,383; increase, £406. Total traffics from July 1st, 1900, £20,995; ditto corresponding period, 1899, £20,136; increase, £859. Miles open, 6·67 chains.

STOCKS AND SHARES.

Wednesday Evening.

A SLIGHT reaction has occurred in the electrical markets after the rise that took place during the first two weeks of the month. The hardening of the money market has combined with a slackening of business to counteract the good feeling which would otherwise have been produced by Lord Roberts' latest cables. The General Election, moreover, is hanging over the markets, and stopping trade in stocks and shares. These various influences are sufficient to account for the small series of relapses recorded in our price lists on the following pages.

In the supply market a fall of 10s. in City of London Ordinary shares is the most noteworthy feature. This, however, still leaves the price ½ to the good, as compared with that on September 12th. The rise last week was probably overdone. We ourselves could ascertain no good reason for the advance. Certainly, the completion of the new works was not enough to justify the rise of 30s. that took place.

Metropolitans show a decline of 10s., mainly owing to the fierce fight which is going on between members of the Marylebone Vestry with regard to the steps to be taken for buying out the company; otherwise the new shares remain hard at 2¼ premium. New Notting Hills are better at 2 premium, the middle price. The buying of London Electrics has ceased for the time being, and the price remains at 2. The last emission of Westminsters is quoted 8½—9½.

Supply Debenture issues keep on the up grade. This week it is Metropolitan 3½ per cent., and Edmundson's 4½ per cent. Debentures that have gained the usual one point. The market for these securities is now an exceedingly good one, and the blocks of stock that were not taken at the times of the various issues have now passed into strong hands. The dealers in the market aver that they have little or no stock left on their books, and that people are still wanting to buy.

The British Electric Traction Company has quite recently issued a circular to those of its members who did not take up the proportion of new shares to which they were entitled, pointing out in this document the substantial advantages that non-applicants would miss. Partly in consequence of this circular, Tractions have been sold by small holders who wanted the money for paying up the liability on the new shares, and the price of the old is 10s. down. The new are steady at 1½ premium. As regards other traction shares, Anglo-Argentine Trams are a very good market upon the report of the directors. Although the distribution is not increased, the carry forward is eight times more than it was for the corresponding period, and the market take it as certain that the next dividend will be larger, unless any very unforeseen circumstances should arise.

Despite the regular dividend declared by the Globe Telegraph and Trust Company, the shares mark a decline of 10s., and can now be bought at a shade under 11. At this they look attractive as a sound second-class investment, yielding a shilling or two under 5 per cent. The highest price touched this year was 11⅝, but last year it was 13¼, nor has the quotation been under 10⅝ since 1898. No change has taken place in the Preference shares this week. Submarine Cables Trust retains the rise which it lately made.

The dulness of Anglo-American telegraph stocks is the only noteworthy feature of the telegraph department. Both the "A" and "B" descriptions have slackened, but the Ordinary is unaltered at 60½. Indo-European shares have come into the market, and the price has receded a point. A good deal of noise was made in the early part of the week over West India and Panama shares, but very few changed hands, and the prices of the various issues are without material change. West Coast of America 4 per cent. Debentures have improved to par buyers. These, it will be remembered, are guaranteed by the Brazilian Submarine Telegraph Company.

The manufacturing market got a selling order in Telegraph Construction on Monday, and the price was lowered a point. It shows how slight is the actual volume of business doing when a single bargain in a small number of shares can influence the price to the extent of a pound. India-Rubber Debentures were *ex div.* on Tuesday, and the 2 per cent. has been deducted from the price. Babcock & Wilcox shares are 2½, the new 2⅜, and the Preference 1⅜. Willans and Robinson are hard at 11, the report being considered very satisfactory, and the Preference are better at 7⅛. Alliance Electrical Preference remain at 1 middle. Electric Construction are up a small fraction, and there are buyers about for Edison & Swan shares, for which a seller can now obtain £2. Henley's latest shares are quoted 12 to 12½.

Central London shares carried-over at 10⅛, and the contango rate was the comparatively light one of 4 to 5 per cent. The jobbers in the market are complaining that business in these is dwindling away, while in the stocks of the other two electric railway companies now operating in London, hardly a bargain a day is done.

A strike of motormen is said to be proceeding on the Oldham, Ashton and Hyde system, but as the market is a purely provincial one, the disturbance is hardly noticed in the London Stock Exchange.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation September 19th.	Closing Quotation September 26th.	Business done during week ended September 26th, 1900. Highest.	Lowest.
110,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —103	...	...
125,000	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	85 — 90	85 — 90	...	...
875,520	Anglo-American Telegraph	Stock	3 %	£3 9s.	73/6	59 — 62	59 — 62	60⅛	...
3,062,240	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	110½—111½	110 111	111	110⅛
3,062,240	Do. do. Deferred	Stock	...	18s. %	£1 7s.	11⅜— 12⅜	11½— 12	12	11 11/16
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	3 %	4 %	2½— 3½	2½— 3½	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	165 —175	165 —175	...	...
1,563,078£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	101 —103	101 —103	102⅜	102
16,000	Cuba Telegraph	10	7 %	8 %	7 %	6½— 7⅛	6½— 7⅛	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	15 — 16	15 — 16	15⅞	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 —104%	100 —104 %	...	...
60,710£	Direct United States Cable	20	3¼%	3½%	3 %	10⅜— 11¼	10⅜— 11¼	...	...
111,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	149 —154	149 —154	151½	149¼
1,795,000	Do. 3½ % Pref. Stock	100	...	...	...	99 —102	99 —102	99½	99
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	114 —119	114 —119	115	...
250,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	15 — 15¼	15 — 15¼	15¼	15
6,700£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	...	...	... — ...	... — ...	...	...
26,600£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	...	...	... — ...	... — ...	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	113 —118	113 —118	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	99 —102	99 —102	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	100 —103%	100 —103%	...	...
180,227	Globe Telegraph and Trust	10	4½%	5⅛%	5⅛%	11 — 11½	10⅜—11⅛	11⅛	10⅞
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	14⅜— 15½	14⅜— 15½	15½	14⅞
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	12½%	...	32 — 34	32 — 34	...	...
84,300	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	98 —101	98 —101	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	50 — 54	49 — 53	49	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	103 —106	103 —106	103½	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680	1	...	...	...	¼— ⅜	¼— ⅜	...	...
86,492	Do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	4 %	2½%	¾— 1	¾— 1	...	...
490,000	National Telephone, 1 to 490,000	5	6 %	6 %	5 %	4½— 4⅝	4½— 4⅝	4⅝	4 9/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	14½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	14½	14
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	5 — 5½	5 — 5½	...	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	98 —101	98 —101	98½	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅞— 1⅛	⅞— 1⅛	1 1/16	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	...	...	100 —103	100 —103	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	126 —131	126 —131	...	...
58,000	United River Plate Telephone	5	5 %	6 %	7 %	4⅜— 5½	4⅜— 5½	...	...
16,639	Do. do. 5 % Cum. pref. Nos. 1—16,639	5	...	...	...	4⅜— 5½	4⅜— 5½	5⅛	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000£	West African Telegraph, 5 % Debs.	100	...	...	...	98 —101	98 —101	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	99 —102	100 —103	101	...
389,731	Western and Brazilian Telegraph 4 % Deb. Stock Red.	Stock	...	...	...	... — ...	... — ...	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	14⅜— 15½	14⅜—15½	15 1/16	15 1/16
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	...	...	...	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph	10	¾%	2 %	⅛%	¾— 1	¾— 1	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	...	...	6½— 7⅛	6½— 7⅛	7⅛	7⅛
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	...	...	6 — 7	6 — 7	6⅝	6½
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	105 —108	105 —108	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	6 %	7 — 8	7 — 8	7½	...
12,000	Do. do. 7 % Cum. Pref.	5	7 %	...	...	8½— 9½	8½— 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	9 — 10	9 — 10	9½	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 5⅝	5½— 5⅝	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	6 %	6½— 7⅛	6½— 7⅛	...	...
150,000	Do. do. do. % Deb. Stock Red.	Stock	4½%	...	...	109 —112	110 —113	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000	10	10 %	6 %	4 %	9 — 10	8½— 9½	9⅝	8⅝
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12½—13½	12½— 13½	13⅛	12⅝
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	124 —129	124 —129	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	4 %	8½— 9½	8½— 9½	8⅞	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	11 — 12	11 — 12	...	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Red.	...	...	...	...	107 —110	107 —110	...	...
26,100	Edmundson's Elec. Corp., Ord. Shares	5	5 %	7 %	...	4½— 5	4½— 5	...	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock.	100	...	...	...	99 —102	100 —103	...	...
110,000	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	1⅝— 2¼	1⅝— 2¼	...	...
49,840	Do. do. do. do. 6 % Pref.	5	...	6 %	...	4½— 5½	4½— 5½	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	100 —102	100 —102	101¼	100⅜
85,000	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	13 — 14	12½— 13½	13⅜	13 1/16
220,000£	Do. 4½% First Mortgage Debenture Stock	...	4½%	...	...	111 —114	111 —114	...	...
220,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	96 — 98	97 — 100	...	...
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	14½— 15½	14½— 15½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½— 15½	14½— 15½	15⅛	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 9	8 — 9	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. do. 4 % Deb.	100	...	...	...	85 — 95	85 — 95	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	3 — 4	3 — 4	...	...
70,900	Westminster Electric Supply, Ord., 101 to 80,000	5	12 %	12 %	13 %	12 — 13	11½— 12½	12 7/16	12 1/16

* Subject to Founders Shares. Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

been produced by Lord Roberts' latest cables. The General Election,

Exchange.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation Sept. 19th.	Closing Quotation Sept. 26th.	Business done week ended Sept. 26th, 1900 Highest	Lowest.
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	9 — 10	...	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	93 — 97	...	...	...
30,000	British Electric Traction	10	...	6 %	...	14½ — 15½	14 — 15	15½	14½
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 13	12⅝	12⅜
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	123 —126	123 —126	123½	...
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	⅜— ½	⅜— ½	...	...
50,000	† Do do. 6 % Cum.Pref., 1—50,000 ...	...	...	...	...	⅝— ¾	⅝— ¾	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	97 — 99	97 — 99	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000 ...	5	15 %	15 %	20 %	11 — 12	11 — 12	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,000 ...	5	...	...	...	5⅜— 6¼	5⅜— 6¼	...	...
105,731	Brush Elecl. Enging., Ord., 1 to 90,000	2	3 %	5 %	...	1¾— 2	1¾— 2	1 13/16	1⅞
105,731	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2⅛— 2⅜	2⅛— 2⅜	2¼	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	106 —111	106 —111	...	...
125,000	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	101 —103	101 —103	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	12½%	15 %	15 %	12½— 13½	12½— 13½	12⅝	...
20,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5 — 5½	5 — 5½	...	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	S ock	...	...	...	110 —114	110 —114	...	...
213,533	Central London Railway, Ord. Shares	10	...	...	...	10 — 10⅛	10 — 10⅛	10⅜	10 1/16
61,033	Do. do. Pref. half-shares	5	...	...	...	4⅜— 5¼	4⅜— 5¼	...	...
71,447	Do. do. Def. do.	5	...	...	...	4⅜— 5¼	4⅜— 5¼	5 1/16	...
855,000	City and South London Railway	Stock	1⅞%	2⅛%	1⅞%	58 — 61	58 — 61	59	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000 ...	10	...	...	...	5 — 6	5 — 6	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	6 %	7½%	3¾— 4¼	3¾— 4¼	...	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	99 —102	99 —102	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	6 %	1¾— 2¼	1¾— 2¼	1 1/16	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	6 %	3½— 4½	3½— 4½	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	90 — 92	90 — 92	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1⅞— 2⅛	2 — 2¼	2⅛	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	7 %	...	2⅜— 3¼	2⅜— 3¼	3 1/16	...
140,300	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	102 —105	102 —105	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	10	7 %	7 %	7 %	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12 %	14 %	15 %	12½— 13½	12½— 13½	12⅝	...
30,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	...	5 — 5½	5 — 5½	5⅜	5 1/16
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	...	...	108 —112	108 —112	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	20½— 21½	20½— 21½	21¼	...
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	99 —102	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3¼%	3¼%	3⅜%	8⅜— 9	8⅝— 8¾	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	12⅜— 13½	12⅜— 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	35 — 39	34 — 38	...	...
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	101 — 104	101 —104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	...	8 %	12 %	10½— 11½	10½— 11½	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5½— 5⅝	5½— 5⅝	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	92 — 95	92 — 95	93	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Brompton and Kensington, 4½ % Debentures of £100, 102—105.
National Electric Free Wiring, 12/6 paid, ⅜—½.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 16½—17½.
Do. do. Pref. (£10 pd.), 10—11.
* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—18; 1st Preference Cumulative 6 % £5 (fully paid), 6¾—7½. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 17½.

Bank rate of discount 4 per cent. (July 19th, 1900).

MARKET QUOTATIONS, Wednesday, September 26th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	82/-	82/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	89/-	89/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33	£33	..
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17	£17	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25 10	10s. dec.
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	8¼d.	8¼d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£25	£25	..
a Shellac	per cwt.	65/-	65/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks ..	per lb.	2¾d.	2¾d.	..
METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£80 to £145	£80 to £150	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	8¼d.	8¼d.	..
c ,, Wire, basis	per lb.	8¼d.	8¼d.	..
c Copper Tubes (brazed) ..	per lb.	11¼d.	11¼d.	..
c ,, ,, (solid drawn) ..	per lb.	11d.	11d.	..
g Copper Bars (best selected) ..	per ton	£86	£85	£1 inc.

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£86	£85	£1 inc.
g ,, Rod	per ton	£86	£85	£1 inc.
e ,, (Electrolytic) Bars ..	per ton	£83 10	£83 10	..
e ,, ,, Sheets ..	per ton	£92	£92	..
e ,, ,, Rod ..	per ton	£85 10	£85 10	..
e ,, ,, H.C. Wire	per lb.	9¾d.	9¾d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire ..	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	1/6	1/6	..
h India-rubber, Para fine	per lb.	4/3 to 4/4	3/11½ to 4/2½	inc.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	71/9	71/9	..
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£12 15	£12 15	..
g Lead, English Ingot	per ton	£18 to £18 2 6	£17 15 to £18	inc.
g ,, ,, Sheet	per ton	£19	£19	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9	£9 2 6	2s. 6d. dec.
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£3 13 6	£3 13 6	..
p Silicium Bronze Wire	per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
,, ,, in bars		£58	£58	..
g Tin, block	per ton	£135	£133 to £134	inc.
g ,, foil	per lb.	2/-	2/-	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	9½d.	9½d.	..
j ,, Best Flax, 6 lea.	per lb.	6d.	6d.	..
j ,, Hemp, 8 ply 10 lbs. ..	per lb.	4½d.	4½d.	..
j ,, ,, Russian, 10 lbs. ..	per lb.	5½d.	5½d.	..
j ,, Jute, 180 lbs. rove ..	per ton	£14 10	£14 10	..
k Zinc, Sh't. (Vielle Montagne bnd.)	per ton	£24 5 nett	£24 5 nett.	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yeo & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

* Subject to Founders Shares. Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, BRADFORD, 1900.

RECENT TRAMWAY CONSTRUCTION: WITH SPECIAL REFERENCE TO THE DEMERBE SYSTEM.

By William Dawson (Deputy-Engineer, Bradford Corporation).

(*Section G, September 10th.*)

It is about 35 years since the introduction of tramways into the large towns of Europe, and an account of the changes and developments which have been made in this means of transport would be very interesting from an historical point of view, but of little technical or industrial interest. The principles of construction, the different systems formerly in use, and the mode of traction have all been revolutionised in the comparatively short time which has passed since the introduction of tramways into this country—so that there is little to learn from the past. It would take up too much time to enumerate and investigate all the systems of tramway construction which were successively tried when tramways were generally worked by horse traction, and which have now given place to other methods more suitable for mechanical or electric traction. The first tram rails were laid on either longitudinal or transverse wooden sleepers, but it was found that the wood soon rotted; the sleepers were, therefore, discarded, and experiments made with tramways constructed entirely of metal. The Vignoles rail was adapted for this purpose, and finally rails of the Brocca (or girder) and the Demerbe (or trough) type were manufactured.

The Brocca rail was afterwards adopted in Germany and England under the name of the Phœnix or girder rail. This form of rail was a modification of the Vignoles rail, as the foot or bottom flange was merely widened and laid direct on the soil or on a bed of concrete. It is now generally adopted throughout England, but, in my opinion, has not proved a success. When animal traction only was used, very little attention was given to the fishing of the joints of the rails, but on the introduction of steam and electric traction it was soon found that the joints were unable to stand the increased strain. The fishplates were increased in length and thickness until in some cases they were 3 feet long and 1 inch thick, eight 1-inch fish bolts were used, sole plates were placed under the ends of the rails, narrow steel strips were placed on the top of the bottom flanges of the rails at the joints, and the whole securely bolted together with six ¾-inch bolts. The joints still worked loose, and it is now recognised that all it is possible to do in this direction is insufficient to make a perfect joint. In Germany the ends of the rails were cut obliquely, afterwards they were halved on to each other, or the ends were notched and a fishplate placed in the recess. All possible methods have been tried to prevent the joints working loose, and numerous patents have been obtained for different ways of strengthening the fishing—all costly and not completely satisfactory, in spite of the extra outlay. The girder rail joint is undoubtedly defective, and the trouble which arises is to be attributed partly to the fact that the top and bottom of the plates corrode, as also does the under side of the head of the rail; the fishplates then occupy a less space, and are less in depth than they were when new. The head and bottom flange of the rail is not firmly gripped by the fishplates, and as their proper work is to maintain the level of the ends of the rails under the action of unequally distributed forces, the joint soon becomes loose. It is not therefore surprising that the consideration of the best means of fishing the joints of tramways has brought to the surface numerous, complicated, and often very remarkable methods of dealing with this branch of tramway construction

Fig. 3.—Connection of Rail with Tie Bar.

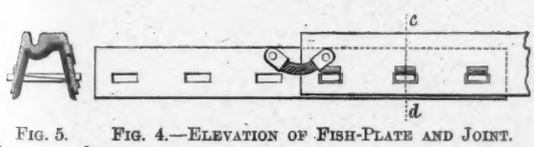


Fig. 5. Fig. 4.—Elevation of Fish-Plate and Joint. Section *c d*.

The Demerbe system of tramway differs entirely from all other types, and possesses in many ways some of the chief attributes of a perfect tramway. It consists of a hollow trough rail, A (fig. 1), and the fishplate, B (fig. 1), is placed inside under the ends of the rails, and exactly fits its contour, the point of application being immediately under the head of the rail. When this system was first introduced, the fishplate was pressed into the rail by means of bolts, but it was soon found that this was not satisfactory, and cotters, E (fig. 1), were used. As the holes in the fishplates and rails are cut at different depths, when the cotters are driven in, the fishplate is forced close up to the underside of the rail. The ends of the cotters are then clinched against the side of the rail, and are thus fixed, and prevented by any possibility from working loose. The rail, when laid in position in the carriageway, is completely filled by means of specially designed tools with concrete composed of four parts of ½-inch unscreened granite shingle to one part of Portland cement.

Fig. 1.—Section of Rail with Fish-Plate.

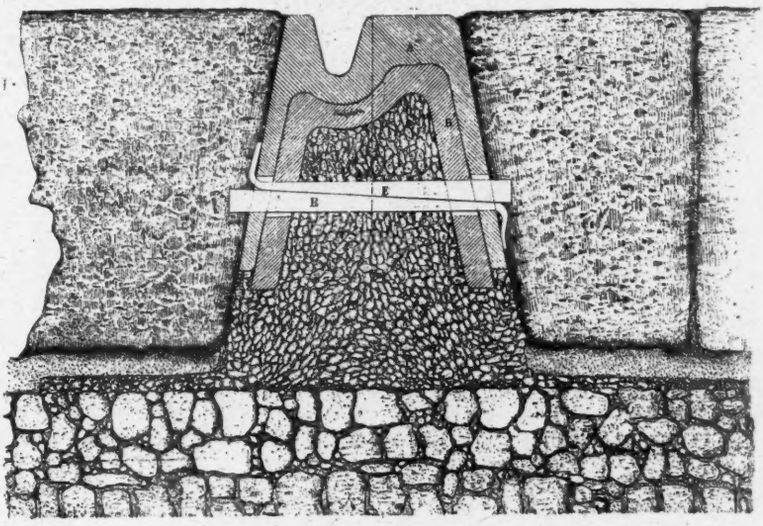
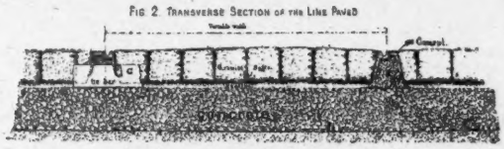


Fig 2. Transverse Section of the Line Paved



The tie bars, G (figs. 2 and 3), used in the Demerbe system are flat, and the use of screw ends, nuts and bolts is avoided. The rail is inserted into two oblique grooves, one of which is cut so as to exactly fit the outer side of the rail, whilst the other is wider, so as to facilitate the introduction of the inner side of the rail. In the space which is left a wedge of soft steel, D (fig. 3), a little smaller than the opening it has to fit, is inserted and driven up. This arrangement of the tie bar enables the rails to be fixed to gauge with almost mathematical exactitude.

In England, as a rule, a concrete foundation is laid the whole width of the carriageway to receive the paving, and when the Demerbe rail is filled with concrete in the manner above described, it becomes attached to the concrete foundation, and is practically part and parcel of the carriageway. It is therefore capable not only of withstanding the strains caused by the cars, but also all the strains and vibrations caused by the ordinary vehicular traffic, without any loosening of the joints or displacement of the paving.

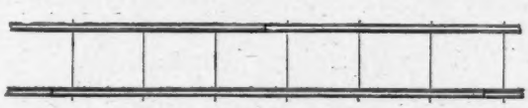


Fig. 6.—Plan of the Line.

The girder rail is laid direct on the concrete foundation, and the oblique strains brought to bear on the head of the rail by the tramcars and the other traffic causes the extremities of the foot or bottom flange of the rail to have a tendency to crush the concrete, and so allows the rail to oscillate on its base. As soon as the rail is subjected to the least movement or vibration, a narrow fissure is produced alongside, which increases in width as the foot becomes more movable. Water penetrates between the paving and the rail, and in frosty weather the paving is uplifted. The joint of the rails is also partly responsible for these defects, as the water finds an easy passage between the rails and fishplates.

It is necessary to take into account another factor which contributes to the grinding away or pulverisation of the concrete. The ends of the rails rest on a sole plate, which is intended to maintain the ends of the rails at one level. When the cars pass over the

track the shock is harder at the joint than on the rest of the rail where the movement caused by the car is more elastic, because the sole plate and the concrete do not support the rail with the same rigidity, and the rails become dented at the joints even when they are in perfect alignment. It follows, then, that the same rigidity should exist at the middle of the rail as at the joint. In the Demerbe system this is so, as the concrete becomes perfectly attached to the rail and the ridge of armoured concrete becomes part and parcel of the foundation itself. The same resistance is offered to the weight of vehicles for the whole length of the rail, no part being found to be weaker or more elastic than another.

In 1894 a short experimental length of the Demerbe rail was laid in the Leeds Road, Bradford, end to end with a similar length of girder rail. Both portions have been subjected to a 5 minutes' service of steam locomotive cars since that time. About three weeks ago a Demerbe rail was removed, in the presence of the Tramway Committee, to ascertain its condition. The rail, joint, and gauge were found to be in every way perfect, and it was only after repeated blows with heavy hammers that the rail could be detached from the concrete foundation, and when raised it dragged up with it part of the foundation.

No money whatever has been spent in repairing this portion of Demerbe tramway, but the adjoining portion of girder rail has been several times repaired during the six years it has been laid down. The setts used alongside the Demerbe rail are splayed to fit the sides of the rail, and laid directly against it, the rail thus serving as a support for the paving; and there is no tendency either for the setts to rise or fall as is the case with the girder rail.

There are in Bradford 40½ miles of tramways, of which 36½ miles are laid on the girder system, with rails weighing 105 lbs. per yard, and fishplates weighing 80 lbs. per pair. There are 4 miles of Demerbe tramway, constructed of rails weighing 70½ lbs. per yard, and fishplates weighing 51½ lbs. each, and the Corporation have further in course of construction an additional 10½ miles of tramway, which they are putting down on the Demerbe system.

The detailed cost per yard of single track on the two systems, based on the price of materials delivered at Bradford, is as follows:—

Demerbe System.

	s.	d.
Rails	10	7·9
Fishplates		9·4
Tie-bars	1	6·8
Wedges		1·4
Cotters		7·1
Track labour, including curve	2	6·0
Rails, &c., carting		1·1
Packing rails (labour)		11·0
Half-inch unscreened granite shingle... ...	1	0·0
Cement		11·5
Team labour		3·2
	19	5·4

Girder System.

	s.	d.
Rails	15	11·2
Fishplates	1	8·8
Marshall's patent joints		9·9
Bolts and nuts		5·4
Soleplates	1	0·3
Tiebars		2·8
Unscreened granite shingle		4·0
Cement		5·1
Labour (packing rails)		3·6
Road scrapings (for plastering rails)		0·6
Track labour	1	3·0
Team labour		1·6
Soleplates punching		1·9
Blacksmith's work		1·3
Repairs to punches		1·9
	£1 3	1·4

Although it will be seen from the foregoing tables that the first cost of the Demerbe track is cheaper than the girder track, this point is not the most important. There is the cost of maintenance to consider, and, judging from the condition of the Demerbe track in Leeds Road after six years' wear and tear, it does not appear that any repairs will ever be necessary during the life of the rail once it is properly laid. This life I should estimate to be about 20 years, whilst the girder rail has to be renewed in 16 years.

The opponents of the Demerbe system when they compare these rails with the girder type state that the latter rail, when laid on two supports, will carry a heavier load than the Demerbe rail under the same conditions. This is quite true, but the Demerbe rail does not act, nor is it intended to act, as a girder. It is supported throughout its entire length by a ridge of concrete, and the rail merely acts as a metallic covering.

The advantages of the Demerbe system of tramway over other systems may be summarised as follows:—

1. The system is simple, being composed of very few parts. It is also cheaper, and can be laid more quickly than the girder system.

2. The rail and concrete resist the heaviest loads without displacement, depression, or other alteration of the track.

3. The cost of maintenance of rails and paving is reduced to a minimum.

4. The tiebars are constructed without rivets or nuts. No punching or drilling of the rails is therefore necessary, as the tiebars can be fixed to any part of the rail by means of the slots.

5. Curves of quick radii are made at the works, and are laid as quickly as straight track.

6. The concrete support effectually prevents water finding its way under the rail.

Having regard to the very large sums spent annually on tramways maintenance, it is of the highest importance that lines should be constructed on a system which promises the longest working life, with a minimum of cost for repairs. The writer, after a considerable experience in tramway construction and maintenance, has no hesitation whatever in affirming that the Demerbe system possesses points which place it far before the girder and other systems, and he can confidently commend it to the consideration of those having in any way to do with the development and extension of facilities for public transport by means of tramways. As Bradford is the only city in the United Kingdom which has tested the Demerbe system, it is, perhaps, not unfitting that this paper should form a contribution to the British Association when it holds its meeting in that city.

Discussion.

Mr. Alexander Siemens (who presided) said he thought it was important for all of them that such an interesting subject should have been brought before them, and nobody was better qualified than Mr. Dawson to tell them of the success of that system in the City of Bradford. They were all interested in the introduction of tramways, and he personally, especially in electric tramways, and the great bugbear they had to meet everywhere was, that the rails formed obstruction to the traffic, and that they did not last, and they worked loose and gave rise to a lot of repairs. If Mr. Dawson now assured them that with his Demerbe system all those troubles were done away with, it was a great step to facilitate the introduction of electric traction in all the great cities of England.

Mr. Shoolbred said that it was not often that such a paper, either there or elsewhere, of such a practical character, was brought before them regarding such a careful and disinterested experiment which had been carried out. Generally, unfortunately or fortunately, authors spoke of their own inventions, but in this case, after the excessive care and length of time that Mr. Cox and Mr. Dawson had given to the subject, they might have the utmost confidence, and be extremely thankful for such careful and valuable experiments to be carried out. With regard to the rail itself as against the Vignoles or girder rails, the one thing which was most striking was that this rail in itself seemed to require a number of component parts. That he should think would prove a disadvantage. The difficulty of taking up the Demerbe rail was shown when the Tramways Committee wanted to inspect it to see its condition. There was no question whatever that all the difficulties which were met with at the present moment in the construction of rails and the interference with the traffic were met with in this construction. One of the most important points probably was that the rail was practically incorporated with the foundation itself, and the two rails formed one uniform structure. That must aid very largely in uniformity, and the uniform working of the rail. He asked Mr. Dawson what was the result upon the setts which immediately adjoined upon the sides of the rail? Were they found to wear or jump or form difficulties in the same way as the ordinary system of rails? This was a difficulty arising through ordinary traffic in towns following the line of the tramway.

Mr. Siemens said that if they compared the cost of the two systems they would find the principal difference was in the weight of the rail, which made a difference of 5s. in the cost. The peculiar construction of that system made it unnecessary for the rail to act as a girder.

Mr. Dawson, in reply, said that the setts did not work loose at all with the Demerbe rail system. His paper contained facts which were obtained from experience extending over six years.

THE DESIGN AND LOCATION OF ELECTRIC GENERATING STATIONS.

By Alfred H. Gibbings, M.Inst.E.E.

(Section G, September 10th.)

The term "central station" is gradually being supplanted by more comprehensive designations.

All design and arrangement in regard to electric work must be with a view to securing the highest average efficiency, together with reliability in operation. Electric works at present do not fulfil these conditions, but that may excusably be accounted for, because it was impossible to foresee modern developments. Electricity, at first used for lighting only, has now come to be used in the form of electric motive power and electric traction. The attempt to supply all these from one generating station has lead to the use of unsuitable plant, to confusion in the station itself, but at the same time to a reduction in prices charged. It has also resulted in a large variation in capital cost per kilowatt of plant. Small and isolated undertakings try to attain equally successful results by other experiments, but fail. Economical production is only possible where both the generating costs and the standing charges are reduced together as the load increases and the system extends. To effect this, generating works must in future be constructed and located with a view to include the supply of energy for motive power, tramways, and

electro-chemical purposes. Details of such construction and location should embody the following points:—

1. The machinery must be designed to generate at high voltage, differing according to the extent of the area and the nature of the system, but it must be suitable for transformation at sub-stations to meet all possible requirements.

2. The type of all boilers, engines, electric generators, switchboards, &c., must be simple and mechanically reliable, even at the sacrifice of some slight maximum economy.

3. All complicated gear and fanciful combinations, such as might lead to possible breakdown, must be avoided throughout the entire arrangement.

4. As far as possible the different units of the respective types of plant should be uniform in design and arrangement, and made to one standard size, thus economising labour, avoiding large "stand-by" plant and spare gear.

5. The buildings should be devoid of all unnecessary embellishments, nor should any attempt be made to confine too many departments under one roof.

6. The location should be such as to ensure a cheap and ready supply and delivery of fuel, and where condensing can be accomplished efficiently and inexpensively.

NOTE ON AN IMPROVED STANDARD RESISTANCE COIL.

By Robert S. Whipple.

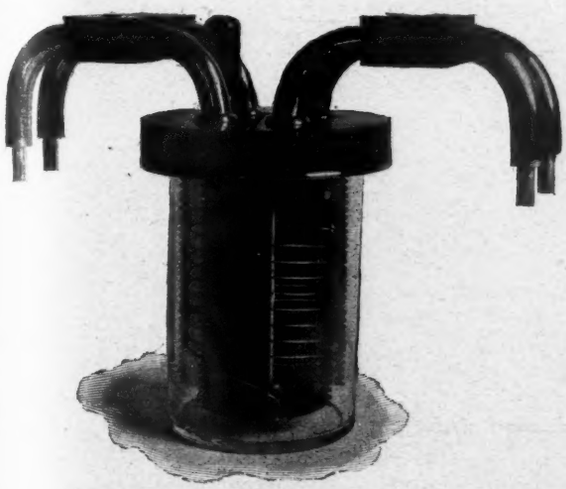
(*Section A, September 12th.*)

In June, 1896, Prof. Burstall read a paper before the Physical Society "On the Use of Bare Wire for Resistance Coils,"—*Phil. Mag.*, September, 1896, pp. 209—224—in which he described a resistance box, the coils of which consisted of bare platinum-silver wire, wound on mica frames, the frames being immersed in an oil with high insulating properties, a method of constructing the coils originally due to Mr. E. H. Griffiths, F.R.S.

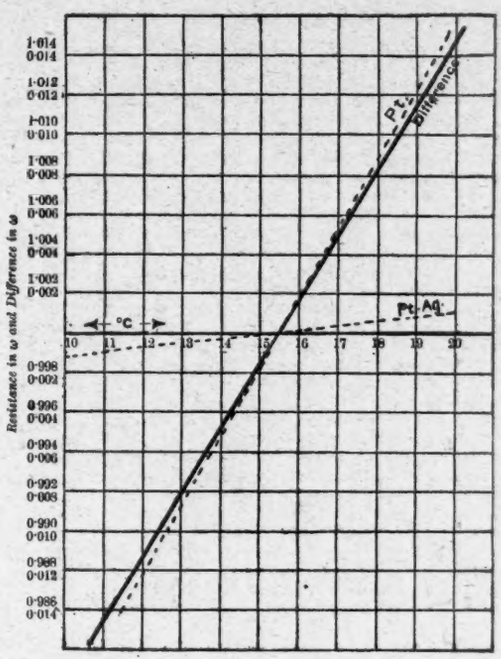
Although Prof. Burstall's paper showed the advantages of this form of resistance coil, it has not, until comparatively recently, been used for standard coils, and only in a few cases for resistance boxes.

This form of coil possesses the following advantages over the ordinary resistance coil:—(1) The coils can be annealed to a dull red heat *in situ*, thus relieving the wire of any strain caused by the winding. (2) The heating of a wire immersed in oil is less than one silk-covered and varnished. (3) The temperature of the wire can be accurately determined by means of a thermometer placed in the oil surrounding the wire. German physicists have adopted a form of coil in which the wire is silk-covered and varnished and then placed in a metal case perforated with holes. The whole coil is placed in an oil bath when in use. This form of coil is open to the objection that it cannot be annealed above 140° C. without causing injury to the silk covering on the wire, and there is a certain amount of lag in the oil obtaining the temperature of the coil.

By request of the Electrical Standards Department of the Board of Trade the Scientific Instrument Company, Cambridge, have designed and made two standard 1 ohm coils, the wires of which are bare and immersed in oil; a modification suggested by Mr. Horace Darwin was also fitted for obtaining the temperature of the coils. The coils proper consist of 0·035 inch Pt Ag wire wound on mica frames, the ends of the wires being attached to stout copper terminals in the usual manner. A 0·008-inch platinum wire is wound alternately with the platinum-silver wire, and is attached similarly to stout copper leads. The illustration clearly shows the



method of winding. Both coils are adjusted to a resistance of 1 ohm at 15·5° C. Owing to the difference in the temperature coefficient of the two wires (Pt Ag 0·00024, Pt 0·00350) a small change in the temperature of the coil causes a comparatively large difference between the resistances of the two coils. This difference being known, the temperature in degrees Centigrade is given by the adjoined table. The table is calculated from the difference in the temperature coefficients of the two wires 0·00350 − 0·00024 = 0·00326 for 1° C. The table of differences, together with the values of the Pt and Pt Ag coils at different temperatures is also shown diagrammatically:—



Temperature of standard coil.			Difference in resistance of the coils.	
10·0° C.	...	...	−0·01793	Platinum coil having a lower resistance than the platinum-silver coil.
11·0	...	...	0·01467	
11·9	...	...	0·01141	
13·0	...	...	0·00815	
14·0	...	...	0·00489	
15·0	...	...	−0·00163	
15·5	...	...	0·00000	
16·0	...	...	+0·00163	Platinum coil having a higher resistance than the platinum-silver coil.
17·0	...	...	0.00489	
18·0	...	...	0·00815	
19·0	...	...	0·01141	
20·0	...	...	+0·01467	

As the temperature coefficient of platinum is about 15 times as great as that of platinum-silver, the resistance of this coil may be measured to one significant figure less than the standard coil without affecting the value for the temperature of this coil. In measuring small resistances, the determination of the last figure to 0·00001 ohm requires considerable care, and the advantage of not being compelled to measure to such a high degree of accuracy is apparent. The two wires being wound on the same frame alternately with each other and immersed in oil are at the same mean temperature. Any temperature gradient in the oil influences both wires similarly, thus doing away with the necessity of a stirrer. The platinum wire is also useful for testing the insulation of the windings of the Pt Ag coil one from the other. The coils are placed in a glass vessel in order that the behaviour of the insulating oil with time may be studied.

THE LEGALITY OF A PRIVATE TELEPHONE.

In a recent issue we published a query relating to the legality of a telephone erected for private purposes, and used solely as a means of communication between two places of business belonging to the same firm. We stated in answer to that query that such a telephone was legal and might be erected without infringing any rights of the Post Office or the telephone companies. As the question is one of much interest to those who suffer at the hands of dilatory clerks at crowded public exchanges, we take this opportunity of dealing with the matter a little more fully.

The probable existence of such a thing as a private telegraph wire has long been in the mind of the legislature. Thus in the Telegraph Act, 1868 (31 and 32 V. c. 110, Sec. 3), the term "any company" (referring to a telegraph company) is said to mean any company, corporation, or persons now engaged in the United Kingdom of Great Britain and Ireland, in transmitting, or authorised to transmit, messages *for money or other consideration* by means of electric or other telegraphs or mechanical agencies, and each and

4. The tiebars are constructed without rivets or nuts. No punch-

to include the supply of energy for motive power, tramways, and

every of those companies. Again, when the exclusive privilege of transmitting telegrams was conferred upon the Postmaster-General by the Telegraph Act, 1869, Sec. 4 (32 and 33 V., c. 73), the following important exceptions from this exclusive privilege were made:—

"(1) Telegrams in respect of the transmission of which no charge is made, transmitted by a telegraph maintained or used solely for private use, and relating to the business or private affairs of the owner thereof.

"(2) Telegrams transmitted by a telegraph maintained for the private use of a corporation, company, or person, and in respect of which, or of the collection, receipt, and transmission or delivery of which no money or valuable consideration shall be or promised to be made or given."

It is quite clear from these enactments that a private telegraph wire is legal; and we may fairly draw the inference that a wire erected to connect the premises of two firms between which there is continual intercourse would also pass unchallenged by the authorities. It remains to consider whether the foregoing principles apply to the telephone. In 1879 a company was formed to acquire the invention of Mr. T. A. Edison, little suspecting that the legislation had already secured that invention as a monopoly of the Crown. The company refused to admit that the term "telegraph," as used in the section of the Telegraph Act, 1869, which confers a monopoly upon the Postmaster-General, could be said to include the "telephone." In consequence of this, an information was filed against them by the Attorney-General. The result of the case was that on December 20th, 1880, Baron Pollock and Mr. Justice Stephen decided against the company. Explaining the position of the Postmaster-General, Mr. Justice Stephen said: "The Postmaster-General shall have the exclusive privilege of transmitting messages or other communications transmitted, or intended for transmission, by any wire or wires used for the purpose of telegraphic communication with any casing, coating, tube, or pipe, inclosing the same, and any apparatus connected therewith for the purpose of telegraphic communication, or by any apparatus other than such wires for transmitting messages or other communications by means of electric signals. This would include electric signals made, if such a thing were possible, from place to place through the earth or the air."

The above statement is sufficiently wide to include, not only our systems of telephonic communication, but wireless telegraph messages as well.

Applying the above principle, and remembering the notable exception in favour of those who send messages without reward, it is clear that a private telephone is legal, in so far as it might be thought to interfere with the monopoly of the Postmaster-General. No monopoly having ever been conferred upon companies, the question does not arise with regard to them.

Another factor must, however, be taken into consideration by all who wish to establish this cheap and expeditious means of communication. Wires cannot be suspended across public thoroughfares at less than a certain height, or fastened to houses, without the consent in the first place of the highway authorities, and in the second place of the private owner.

In the case of Levy *v.* National Telephone Company, which was heard by Mr. Justice Day on December 24th, 1897, a mandatory injunction was granted against the defendants, ordering them to remove their telephone wires from above the plaintiff's house in the Whitechapel Road. It was shown that the wires had been *in situ* for 13 years, and that they caused a nuisance to the plaintiff in the occupation of her house. The Court of Appeal affirmed this decision, Lord Justice A. L. Smith saying that the plaintiff might have cut the wires, but instead of doing so she preferred to bring the action. Similarly with regard to the power to lay a wire under the streets. In all cases must the consent of parties interested be obtained; for, like an ordinary telephone company, the private owner must obviously be denied the privilege extended to the Postmaster-General, namely, that of erecting poles and uprooting the streets without the consent of, but paying compensation to, the local authorities.

THE RESPONSIBILITY OF A TRADE UNION.

The recent case of the Taff Vale Railway Company *v.* the Amalgamated Society of Railway Servants and others, which came before Mr. Justice Farwell, sitting as Vacation Judge, cannot fail to have attracted the attention of all who are interested in the progress of trade unionism. The facts of this important dispute have been so carefully elaborated in the columns of the daily papers, that we need not go into them at great length. The plaintiff company sought an injunction to restrain the society, and two persons, named Bell and Holmes, from *inter alia* watching or besetting, or causing to be watched or beset, the Great Western Railway station at Cardiff . . . . for the purpose of persuading or otherwise preventing persons from working for the plaintiffs, or for any purpose except merely to obtain or communicate information.

An interim injunction was granted by the learned judge without much hesitation against the defendants Bell (the general secretary) and Holmes (the organising secretary of the defendant society). Their liability was immediately determined by the now famous case of Lyons *v.* Wilkins ((1899) 1 Ch. 255), where it was decided that to watch or beset a man's house with a view to compel him to do or not to do, that which it is lawful for him to do or not to do, is, unless some reasonable justification for it is consistent with the evidence, a wrongful act:—(1) Because it is an offence within Section 7 of the Conspiracy and Protection of Property Act, 1875; and (2) because it is a nuisance at common law for which an action would lie. The more important question, namely, whether the society could be restrained from directing their servants to do these wrongful acts was allowed to stand over until September 5th, when Mr. Justice Farwell laid it down, in no uncertain manner, that a trade union *can* be restrained by injunction from employing its servants to do unlawful acts. The importance of this decision can hardly be over-estimated.

It was argued on behalf of the society in question that inasmuch as they were not a real "person," or a body corporate, in the eye of the law, they could not be sued in tort; that a trade union has no being except for the purposes specifically mentioned in the statutes which make them legal. We cannot do better than quote Mr. Justice Farwell's own words in answer to this argument. "If," said he, "the contention of the defendant society is well founded, the legislature has authorised the creation of numerous bodies of men capable of owning great wealth and of acting by agents with absolutely no responsibilty for the wrongs that they may do to other persons by the use of that wealth and the employment of those agents. They would be at liberty (I do not at all suggest that the defendant society would so act) to disseminate libels broadcast, or to hire men to reproduce the rattening methods that disgraced Sheffield 30 years ago, and their victims would have nothing to look to for damages but the pockets of the individuals, usually men of small means, who acted as their agents . . . . . There are acts done by their agents in the course of the management and direction of a strike; the undertaking such management and direction is one of the main objects of the defendant society, and is perfectly lawful; but the society in undertaking such management and direction, undertook also the responsibility for the manner in which the strike is carried out."

This momentous judgment, which was delivered in time to attract the attention, if not the indignation, of the Trades Union Congress, places a formidable weapon in the hands of employers who are troubled from time to time by the overbearing attitude of the unions. Once it can be proved that the illegal means adopted by individuals are due to the instigation of a powerful society, that society can be brought to book in a Court of Justice, and can, we doubt not, be made liable in damages to the victims of its oppression. This judgment may serve to mitigate the hardship which can always be imposed upon the master by those who endeavour, under the protection of the case of Allen *v.* Flood, to induce workmen to break the contracts into which they have entered with their employers. Rumours of an appeal are already in the air; but we venture to think that the Court of Appeal, in properly interpreting the law of the land, and guided, as it always is, by the first principles of justice, will hesitate long before it places in the hands of the trades unions a power which can so easily be abused.

ELECTRICAL ENTERPRISE IN ARGENTINA.*

Electrical enterprise has received great impetus in this country during the past three years, and there is still a large field open to it, but it is greatly hampered by taxation, thus the Light Companies in Buenos Aires are compelled to hand over 5 per cent. of their gross receipts, whilst the tramway companies have to pay 6 per cent. This taxation is out of all proportion to the advantages conceded by the authorities.

The reason why there are not more electric trams in this city at the present time, is that the municipal authorities imposed upon each company, after it had obtained its concession the unreasonable demand of lighting every street through which it might pass. Fortunately this tax was repealed, but only when the authorities were convinced that if it were put into force the existing electric tramways would have to disappear.

We have here a wide field for electrical enterprise, and large tracts of mining territory awaiting the development of electrical power stations, to open up the wealth that is lying beneath the soil, but for this we require capital and this will not come so long as the authorities persist in creating taxes which render all investment unremunerative.

The telegraph system of Argentina includes national, provincial, railway and private companies' lines, and all belong to the "Argentine Convention," which also includes those of neighbouring States.

The tariff is uniform over the different systems. The lines are all aerial, and the construction is on iron, palm or quebracho poles. The wire is generally No. 7 galvanised iron, although the cable companies employ copper. The insulators are of the Bell pattern. The cost of construction varies from $155 per kilometre to $300 and even more in outlying districts.

In 1896 the revenue of the National Telegraph Department amounted to $1,133,707, and in 1897 to $1,182,056. The tariff for national and private lines which form part of the Argentine convention is for each word up to 10, 5 cents per word, and 3 cents for each of the following words, the minimum number of words being taken as 10.

The total length of telegraph lines in the Republic to date is as follows:—

* Abstract of paper read before the Institution of Engineers of the River Plate, by E. Danvers.

1 ohm at 15·5° C. Owing to the difference in the temperature coefficient of the two wires (Pt Ag 0·00024, Pt 0·00350) a small

to transmit, messages *for money or other consideration* by means of electric or other telegraphs or mechanical agencies, and each and

	Lines.	Conductors.
National	19,609 kilom.	44,578 kilom.
Provincial...	5,682 „	8,741 „
Railways	16,408 „	35,495 „
Private	2,720 „	5,640 „
Grand total	44,419 kilom.	94,454 kilom.

The telephone system throughout the country is in the hands of private enterprise, and not under Governmental or municipal control. Concessions are obtained by application to the various municipalities to run overhead wires. Although at the present time the companies come under no control, attempts are now being made by the Post and Telegraph Department to obtain control over the telephone companies working in the City of Buenos Aires on the ground that as their lines run into the province of Buenos Aires they should therefore come under national supervision.

The cost of subscription in Buenos Aires is high, when compared with that charged, and the service given, in other large cities of Europe and America.

The tariff for the city is as follows:—Business houses, 26s. per month; private houses, 17s. 3d. per month; hotels, 43s. 4d. per month.

The majority of the lines are galvanised iron, although some of the trunk lines are of copper. Several of the trunk lines are worked on the metallic circuit by means of translators, and these give very satisfactory results.

All the subscribers are on the single circuit with earth return, but the Union River Plate Telegraph Company in Buenos Aires is now installing a metallic circuit system with underground mains.

Telephone companies in the city of Buenos Aires have to pay the following national taxes:—Head office, $500 per annum; branch office, $50 per annum.

The municipal taxes are:—Posts $2-4 per annum according to district, and for underground work the following:—Street boxes, $5 per year; pits, $15; cable laying, $100 per square, and $5 per annum, besides various other taxes, for repairs to pavement, &c.

Considerable trouble has been experienced by the telephone companies throughout the country from the electric light and traction companies, and the method adopted has been to establish an earth circuit common to all subscribers. This has partially improved matters, but in Rosario where the Electric Light Company uses rectifiers there seems to be no hope for improvement until underground mains are employed.

The total capital represented by telephone enterprises is $5,300,000 gold.

In connection with long distance telephony, and in particular the line between La Plata and Mercedes, this line has the following systems:—Grand dock to La Plata single-line iron, 10 kilometres; then through translators to the metallic circuit (copper) to Buenos Aires, 50 kilometres; through another translator, to single line (iron) to Flores, 5 kilometres; through another translator, on to the metallic circuit (copper) to Mercedes, 93 kilometres; then through another translator on to the single lines (iron) of the subscribers. This line has therefore three single lines of iron, two metallic circuits of copper, and four translators, and it is worthy of record that the talking over this distance of 158 kilometres is perfect.

To-day the city of Buenos Aires is lighted by means of 702 arc, 13,445 gas, and 8,307 kerosene lamps, at a cost of $120,000 per month.

The public arc lighting is done by three companies, two by direct current with two or more lamps across the outers, according to voltage, and the other by alternating current with a step down transformer to each lamp, placed across the outer and middle wires of the system.

The following are the taxes that the electric light companies have to pay in the city of Buenos Aires, and they are, to say the least of it, exceedingly heavy:—

National Government tax ...	$500—1,000 per year.
Transformer pits	$15 „
Street boxes	$5 „
Boiler tax	From $100—400 per boiler.
Seal for same, each	$10.
Opening of street to make house connection	$10 each time.
For use of subsoil with mains ...	5 % of year's gross revenue.
Tool carts, each...	$5 per year.
Laying cables, per square ...	$100.
Opening up of streets within first year of paving.	$200 each time.
Inspection of sidewalks after removal.	50 cents per 1 metre.
Permission to construct transformer pits.	$30.
Permission to construct street boxes.	$10.
Users of electric motors have to pay from	$15 to $45 per annum, according to size.

The municipality also fixes the maximum price per kilowatt that the companies may charge.

Material for public lighting and power stations is allowed into the country duty free, other material pays a duty of 25 per cent. *ad valorem*.

To-day there are in the country 36 stations, with an approximate capital of $9,000,000 gold and an output of 21,000 B.H.P. Of these stations 26 are direct current, 8 alternating.

With the exception of the city of Buenos Aires all the electric light mains in other towns are overhead.

There are in the city of Buenos Aires at the present time four public companies, one private firm, three municipal and two Government stations supplying electric light for public and private lighting, and the total length of underground mains is not far short of 1,200 kilometres.

The Stone system of train lighting was introduced about four years ago, and is now largely in use on the railways.

There is a very large field open in this country for electric traction, especially in the leading cities, in Buenos Aires itself, a city with over 800,000 inhabitants, and which is rapidly extending, electric traction has a large field, as rapid transit is what is needed, so as to prevent the population, especially the poorer classes, from crowding into a very limited area, as they do at the present time.

The Buenos Aires municipality has unfortunately imposed the following heavy taxation, which in itself is sufficient to choke all progress in this line:—

Taxes Paid by Tramway Companies.—A tramway operated electrically pays the following taxes:—On being opened to public service, $500 m/n c/l per square of single track within a radius of 8 squares from the Plaza de Mayo. From 8 to 20 squares $400 m/n c/l per square of single track. Beyond 20 squares, in paved streets, $200 m/n c/l per square of single track. Payment to be made to the municipality for each siding, curve, or junction after the lines are opened to public service of $500 m/n c/l. Payment to the municipality of 6 per cent. on the gross receipts of the tramway company (that is to say, on value of tickets and special passages, but not on rental that may be received from other companies for joint use of track, &c.; efforts are being made to cause the companies to pay 6 per cent. on all receipts, such as rental advertisements, &c., in spite of the fact that the 6 per cent. was created as a tax for the maintenance of the paving). A monthly payment of $300 to the municipality for the services of the municipal inspectors. A yearly tax of $50 m/n c/l per square of single track for all lines laid on paved streets. *National Tax.*—Five per mil as "contribución directa" on the valuation of the properties. Also municipal taxes, such as 2 per cent. monthly on estimated rental of buildings and lands, taxes on engines, stables, cleaning, &c., &c. Buenos Aires has before now been called the City of Tramways. There are 10 horse and electric lines working to-day, which represent a capital of about seven million sterling. The kilometrage is:—Horse, 358; electric, 89.

The passenger returns for the year ending March 31st last were 111,820,364 horse and 16,584,576 electric, making a grand total of 128,404,940 passengers. The returns for 1898 were 105,964,631, an increase of 21 per cent. in about a year. These figures speak for themselves.

The cars are all made in the United States. The feeder cables are laid in Doulton earthenware conduits, are lead-covered, and made by the British Insulated Cable Company. The following figures concerning mileage and passengers are of interest:—Year 1899 miles run, 2,591,686; passengers, 10,569,891; receipts, £115,924. Year 1898, miles run, 1,357,915; passengers, 6,945,783; receipts, £66,598; which gives an increase for 1899 of 1,233,771 miles run, 3,624,108 passengers, and £49,326 receipts. In the directors' report for 1899 I find that the receipts per mile were 9½d. The average consumption of current per mile run for 1899 was 1·3 of an English Board of Trade unit [1,000 watts]; this figure has since been reduced to 1·2.

Amongst the smaller electrical enterprises are the City Messenger Service, which dates back to 1888, and to-day has six offices, 49 circuits, and 3,312 call boxes. In 1899 the calls numbered 262,000.

The sugar refinery in Rosario employs electricity for the refining of the sugar, but the process is kept a profound secret.

In Buenos Aires there are now to be found several large electro-plating establishments.

Before long it is probable that electric smelting works will be established up country; there are already two carbide of calcium factories in course of erection in Cordoba.

The total capital employed in electrical enterprises in this country at the present time is as follows:—

	$ gold.
Electric light, public companies	9,000,000
Electric light, private installations	500,000
Train lighting	100,000
Telephones	5,300,000
Telegraphs (cables not included)	6,000,000
Tramways...	15,000,000
Various companies	200,000
Importers, contractors, &c.	3,000,000
Total	$39,100,000

Or, say, very nearly eight millions sterling.

TECHNICAL EDUCATION.

Every day furnishes fresh evidence of what we have frequently emphasised, namely, that there is a great dearth of technical knowledge at present in England. We are reminded again of this by a pamphlet on the subject written by Mr. F. Brocklehurst, M.A., and issued by the Technical Institution Committee of the Corporation of Manchester. The writer discusses and compares the position here with that in Germany and America, very much to the disadvantage of England. He condemns what he considers the waste of money on such costly technical institutes as the many in London

unless some reasonable justification for it is consistent with the

the River Plate, by E. Danvers.

that are available for evening classes only. We would not abolish the evening student, but we would make of these places schools for day students as well. We cordially recommend Mr. Brocklehurst's pamphlet to the consideration of the committees of all technical schools.

Reference is made to the apprenticeship scheme of Messrs. S. Z. de Ferranti, of Hollinwood, Oldham. This firm has undertaken to move certain selected apprentices from one department to another, including the drawing office. These apprentices are selected by their success at evening classes, not so serious a consideration as it is in London, owing to better facilities for travel to and from home and school. They offer also a Day Scholarship at the Manchester Technical School, where the students' fees will be paid, and also wages at the standard for his age, and he will be required to work in the shops on occasions of all school holidays that are not at the same time shop holidays. Stated briefly, Messrs. Ferranti have made something like a partial reversion to the old-time days when a man took an apprentice and taught him his trade thoroughly.

Again, Messrs. B. and S. Murray, of Openshaw, offer to take their apprentices at 17 years old, fresh from school, at the same wages as they would be earning at 17 if they had started at 15 years of age as apprentices, but the boy must gain a technical scholarship at 15, and he will be paid 7s. a week for the two years he is at the technical school.

The author calls on parents to sacrifice more to give their boys a better education, in place of hurrying them to work with so little schooling, and cites Scotland as a country where parents do make sacrifices to educate their children.

After all, of what value is the one solitary day student provided by Messrs. Ferranti? We confess a mere drop in an ocean of need, but it is not for its actual magnitude so much as for an example to others that the plan is so commendable.

To turn abroad, there are 400 day students in the school of the small town of Winterthur, near Zurich. These students remain at school until 16 years of age, and then pass two more years in the technical school. In the Zurich Polytechnic there are hundreds of students, at Darmstadt 1,100, all over 18 years of age, and at Charlottenberg, near Berlin, more than 2,000. In all the German technical schools the day students number over 11,000, and in American engineering colleges there are nearly 10,000 day students.

Manchester is spending £200,000 on its school, and, so far, has 130 students. The expenditure seems to be altogether out of proportion to results at present, but doubtless as time goes on and the schools grow in popularity a better showing will be made.

The author blames the country squires for the neglect which has divorced brains from agriculture until our agriculture actually requires to be buttressed by the rest of the country. Evidently he believes that our manufacturers ought promptly to learn the lesson, and follow the example of Messrs. Ferranti. The current war has shown only too plainly how our moneyed classes, who contribute so largely to the manning of the War Office and the officering of the Army, have divorced their brains from their business to the great and manifest injury of England. The moneyed class who are in trade do just the same.

CURRENT SPECIFICATIONS.

XXX.—SHEFFIELD EXTENSIONS.

SUMMARY.

Extent of Contract.—Supply of two 600-KW. steam alternators and alteration of existing plant.

Present System of Working.—Single-phase 2,000 volts 100 ~.

Future System of Working.—Two-phase 2,000 volts 50 ~.

Type of Engines.—Inverted cylinder triple-expansion marine type.

Type of Alternator.—Stationary armature with revolving field magnets.

Speed of Combination.—125 revolutions per minute.

Steam Pressure Available.—150 lbs. square inch at stop valve.

Condensing Plant.—Not included in this contract.

Guaranteed Steam Consumption.—With 150 lbs. square inch pressure, and 24-inch vacuum, not to exceed:—

Full load	14·5	lbs. per	I.H.P	per hour	92%	mechanical	efficiency.
¾ "	13·5	"	"	"	90%	"	"
½ "	14·0	"	"	"	90%	"	"
¼ "	14·5	"	"	"	85%	"	"

Method of Winding on Alternator.—Two-phase, with separate circuits 2,000 volts 50 ~.

Stipulated Overload.—20 per cent. for three hours without undue heating.

Short-Circuiting Current.—Not to exceed 3½ to 4 times the normal current.

Permissible Temperature Rise.—After 12 hours at normal full load, not more than 55° F. above surrounding atmosphere.

Alternator Efficiency.—Not to be less than 94 per cent. at full load and 92 per cent. at half load, including exciting watts.

Exciting Arrangements.—Direct coupled exciter to be provided for each machine.

Alterations to Existing Machines.—Five machines (125 KW., 300 KW., 300 KW., 600 KW., 1,000 KW. sizes) of Messrs. Ferranti's manufacture, and one machine (600 KW.) of Brush Company's make, to be converted from single-phase 2,000 volts 100 ~ machines to two-phase 2,000 volts 50 ~ machines.

Specified Date of Completion.—Two new 600-KW. sets by April 30th, 1901, earlier if possible.

Penalty for Late Completion.—*One per cent.* per week after date given by contractors.

Date for Repairs.—These to be carried out in order specified by engineer.

Stipulations as to Removal of Foreman.—None.

Stipulations as to Wages to be paid to Workmen.—Unsatisfactory, see comments below.

Terms of Payment.—80 per cent. as work proceeds, 10 per cent. on completion, 10 per cent. at end of 12 months' period of maintenance.

Arbitration Clause.—Limited, see comments below.

Date for Receipt of Tender.—October 6th, 1900.

This specification is the work of Mr. S. E. Fedden, the recently appointed chief engineer and manager of the Corporation electric supply department. It states the lines along which the Corporation have determined to advance in their efforts to popularise the supply of electric energy for light and power purposes in the city.

It will be remembered that a year or two ago the Corporation purchased from a local company the electric lighting undertaking they had inaugurated on the single-phase alternating current high tension system. Previous to the completion of the purchase the City Council had decided upon a separate power station for the electric tramway system, so that when the question of future policy was under consideration the issue was narrowed down to the supply of lighting and power. We think that in the adoption of the two-phase 50 ~ system the Corporation are moving along the line of least alteration to present plant towards what promises to be a very effective solution of the light and power problem. It will be remembered that this two-phase system is now being adopted at Wandsworth and Leeds, where the conversion process from 100 ~ is in progress, and at Fulham where the station is laid down on these lines.

The stipulation that "the distribution of steam in the high pressure cylinder of the engine is to be controlled by McLaren's patent governor and automatic expansion gear combined acting directly upon a balanced trick valve," seems to point to an already formed decision on the part of the engineer as to the make of engine to be adopted, while the alternator specification, though not so obviously favouring a particular make, gives such minute details of design that many manufacturers will feel themselves debarred from tendering.

We may, perhaps, remind the engineer that in the highest quarters it is generally accepted that the function of a consultant, or one acting in that capacity, is to specify results to be attained, leaving to the manufacturer a free hand as to the methods to be adopted to gain those ends.

The steam consumption and efficiency guarantees demanded are stated in the summary, and will be seen to be of a very stringent character. There seems to be a spirit of rivalry just now amongst station engineers as to who can secure from manufacturers the highest guarantees of excellence.

There is not likely to be much competition for the task of altering the existing plant to render it suitable for two-phase 50 ~ working, as the original makers are in each case in the most favourable position to undertake the work.

We have the same objection to urge against the arbitration clause as in so many recent specifications. Its operation is limited by reason of certain reservations in favour of the engineer. Thus we read:—

Every dispute, question, difference, or controversy arising between the Corporation and the contractor, or between the engineer and the contractor (except as to matters or things left to the sole decision of the engineer), under these conditions *shall,* after the completion and delivery, or alleged completion and delivery, of the works, and on the demand, in writing, of either party, *be referred to arbitration,* pursuant to the provisions of the Arbitration Act, 1889, or any Act or Acts amending the same.

The exceptions are stated in the preceding clause to be:—

The decision of the engineer shall be final and binding as to the manner of carrying out the works, and as to the quality of the material and workmanship, and *as to the true intent and meaning o the drawings and any clause in this specification*

It is precisely on these points that there is likely to be disagreement, and upon which it is only just that power should be reserved to either party to refer, if need be, their case for the consideration of *an independent arbitrator*.

We have, again, powers granted to the engineer to stop work for any period he considers proper, and to grant an *equivalent period* to the date for completion. That under certain very probable circumstances, *an equivalent period* is not fair compensation to the contractor has been clearly pointed out on several occasions, and we trust that tenderers will make their position clear on the matter when sending in their offer.

Many of our readers will recollect the stand taken by Messrs. Ferranti against the wages clause in the contract they were asked to sign on obtaining the order for the last extension, a year and a quarter ago. The same clause is again inserted in the specification, and as there is very likely to be another battle royal on the question of its acceptance by the successful contractor, we reprint it in full. It states :—

The contractor *shall pay all workmen employed by him* in carrying out the contract in the city of Sheffield *not less than the standard rate of wages recognised by trade societies in Sheffield* in each branch of trade represented in executing the contract, and shall observe the recognised hours and proper conditions of labour. For all work prepared outside the city of Sheffield, and to be used in the city, he shall pay to all workmen engaged in such last-mentioned work not less than the minimum standard rate of wages recognised by trade societies where such work is prepared, and *if there shall be no such standard rate of wages in such place, he shall pay to such workmen engaged in the said work outside the city not less than the standard rate of wages recognised by trade societies in Sheffield*, in each branch of trade represented in executing the work specified, and shall observe the recognised hours and proper conditions of labour prevailing for the time being in the said city. *In case of breach* of the said conditions as to the wages, *the contractor shall pay to the Corporation* a sum of money equal to *three times the amount by which the actual rate of wages paid by him at any period during the execution of the contract for any particular class of work is below the said prescribed minimum standard rate of wages* for the same class of work during that period. The several conditions shall apply to any sub-contractor to whom the work contracted for or any part thereof may be let by the contractor under and subject to the following clause.

The contractor shall not assign or cede his contract or any part thereof, nor shall he sublet the same or any part thereof to any person or persons, company or companies, to any extent, or in any manner beyond what, in the opinion of the engineer, to be signified in writing by his hand, shall be necessary or customary.

The portions of the clause to which Messrs. Ferranti took exception were those stipulating that in "each branch of trade represented" the Sheffield trade union rates should be paid in default of district trade union agreements with the employers modifying these rates, and also the penalising of the contractor by the Corporation for breaches of this stipulation. Messrs. Ferranti not only declared that they paid "fair wages," but offered to prove their statement by production of their books. They, however, considered the clause as worded an attempt to nullify the agreement arrived at the end of the last engineers' strike between the Engineering Employers' Federation and the Amalgamated Society of Engineers, and therefore they declined to accept it. This agreement gave liberty to an employer to employ whom he would on a machine tool in his workshop, and pay what the work done was worth; the clause as above worded might be so construed that any engineering work should be paid full trade union rates for skilled workmen, and therefore it unduly hampered the employer.

As might be expected this attitude was not approved in trade union circles in Sheffield, and many efforts were made to enforce the Council to insist on the acceptance of all its general conditions.

After a clear statement of the opinions of the Electric Lighting Committee as to the need for new plant, and the difficulty of obtaining it elsewhere on different terms, the Council gave way, and signed the contract *omitting this clause*. We hope a similar stand will be made in this case, and that this attempt on the part of Trade Unionists to impose their condition of employment upon electrical engineering firms in the guise of provisions for the enforcement of fair conditions of labour may be again frustrated.

It is useless for manufacturers to expect that by tamely submitting to succeeding encroachments upon their liberty of action, they can avoid a battle with the organisations which claim to represent the workers. They cannot; it is only by constant watchfulness in all directions, a stern refusal to surrender any of their rights, and fair and honourable dealings with their own employés that they can maintain their position, and preserve that freedom of action which is necessary to enable them to meet, not only home, but American and Continental competition.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1900.

Compiled expressly for this Journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

16,049. "Improvements in electric commutator bars." The British Thomson-Houston Company, Limited. (W. Le R. Emmet, United States.) Dated September 10th. (Complete.)

16,050. "Improvements in controlling high potential electric circuits." The British Thomson-Houston Company, Limited. (E. W. Rice, jun., United States.) Dated September 10th. (Complete.)

16,051. "Improvements in systems of electrical distribution." The British-Thomson-Houston Company, Limited. (C. P. Steinmetz, United States.) Dated September 10th. (Complete.)

16,053. "Improvements in systems of electrical distribution." The British Thomson-Houston Company, Limited. (C. P. Steinmetz, United States.) Dated September 10th. (Complete.)

16,064. "A new or improved apparatus for automatically charging accumulators." B. Klein. Dated September 10th.

16,082. "Combined reversing switch and automatic maximum current interrupter for multiphase reversed current motors." C. de Kando. Dated September 10th. (Complete.)

16,091. "Walsh's connection rope to table attachment for use in the drawing-in of electrical cables through iron, earthenware, or other conduits." E. Walsh. Dated September 11th.

16,127. "Improvements in dynamo-electric machines." The British Thomson-Houston Company, Limited. (C. P. Steinmetz, United States.) Dated September 11th. (Complete.)

16,128. "Improvements in compounding electric alternators. The British Thomson-Houston Company, Limited. (E. W. Rice, jun., United States.) Dated September 11th. (Complete.)

16,129. "Improvements in dynamo-electric machines." The British Thomson-Houston Company, Limited. (C. P. Steinmetz, United States.) Dated September 11th. (Complete.)

16,130. "Improvements in high potential electric switches." The British Thomson-Houston Company, Limited, (E. M. Hewlett and W. Le R. Emmet, United States.) Dated September 11th. (Complete.)

16,141. "Improvements in apparatus or means for varying the speed of electromotors." G. J. Churchward and F. L. Wait. Dated September 11th.

16,147. "Improvements in electrically-propelled vehicles." T. J. Ryan. Dated September 11th. (Complete.)

16,148. "Improvements in electrically-propelled vehicles." T. J. Ryan. Dated September 11th. (Complete.)

16,159. "Improvements in and relating to lifting magnets." E. B. Clark. Dated September 11th. (Complete.)

16,164. "Improvements in electrical measuring instruments." A. C. Heap. Dated September 11th.

16,225. "Improvements in measuring electrical energy and in apparatus therefor." R. Kennedy. Dated September 12th.

16,226. "Improvements in or relating to machinery or apparatus for covering electric cables, wires and other cores." I. L. Berridge and B. Kerr. Dated September 12th.

16,289. "Improvements in induction coils or transformers." H. W. Sullivan. Dated September 13th.

16,290. "Improvements in and connected with electric circuits for the transmission of energy by variable currents." G. A. Campbell. Dated September 13th. (Complete.)

16,291. "An electro-magnetic regulator of the admission valves of gas or oil motors." C. D. Abel. (La Societe Anonyme des Anciens Etablissements Panhard et Levassor, France.) Dated September 13th.

16,293. "Improvements in electric furnaces." J. Imray. (La Societe Electro-Merallurgique Francais, France.) Dated September 13th.

16,299. "Improved construction of electric switch." E. Schulz. Dated September 13th.

16,357. "Improvements in underground electric railway systems." J. D. O'Brien. (C. A. Balph, United States.) Dated September 14th.

16,375. "Improvements in accumulator boxes." H. H. Hill and W. F. Hill. Dated September 14th.

16,395. "Improvements in electric locomotives." J. S. Raworth. Dated September 14th.

16,408. "Improvements in the electrodes of electro-chemical accumulators." J. von der Poppenburg. Dated September 14th. (Complete.)

16,424. "Improved automatic electrical cut-in and cut-out switches." J. Edmondson. Dated September 15th.

16,458. "Improvements relating to the terminals of fuses, switches and other electrical appliances." A. G. W. Baxter. Dated September 15th.

16,466. "Improvements in electro-hydraulic brakes." A. Goldschmidt. Dated September 15th.

16,483. "Improvements in portable electric batteries." M. E. Fuld. Dated September 15th. (Complete.)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1898.

12,385. "Improvements in portable electric lamps for use in mines and other places." S. F. Walker. Dated June 2nd. A vulcanite or other insulating vessel either circular or otherwise is made with one or more flat vertical partitions

dividing it into sector shaped cells in plan. It is placed in an aluminium case provided with a screw-threaded rim to engage a metal ring on which a conical glass is held by wires and a top plate. The rim of the case also carries vertical pins which engage slots in a flange on the vessel and in a thick vulcanite cover under the ring. The cover carries an incandescent lamp; it is slotted to receive metal strips connecting the electrodes and lamp, and has circular recesses to receive the upper ends of cylindrical carbon electrodes, these parts being all coated with black japan varnish, and the recesses filled with a suitable cement described in Specification 3,772, 1897, and covered with thin vulcanite attached by Chatterton's compound. The carbon electrodes are saturated with sulphur and electroplated for attachment by solder to inner and outer brass rings into which flanged discs of vulcanite containing much sulphur are screwed. The metal rings also carry radial pins to enter slots in the vulcanite cover. The discs carry brass screws on which pure zinc rods are screwed. The rods may be provided at their lower ends with brass screws carrying milled vulcanite heads to facilitate this. Specification 24,448, 1895, is also referred to. 4 claims.

12,431. "Improvements in apparatus for the production of electricity in railway carriages and other vehicles." E. J. Preston, care of J. Stone & Co. (Gould Coupler Company.) Dated June 2nd, 1898. Relates to the manner of supporting and driving the dynamo employed in the system of electric lighting for railway carriages and other vehicles described in Specification No. 1,611, A.D. 1895. According to the present invention the dynamo is suspended at each end by a pair of links from the under frame of the carriage. The driving belt is maintained taut by the weight of the dynamo and the tension of the belt is regulated by means of an adjustable counterweight or an adjustable spring. The belt and pulleys may be enclosed in a gear case similar to those used on velocipedes, one end of which is suspended by a spring from the axle frame of the carriage. 4 claims.

12,461. "Improvements in and in relation to 'fenders' for electrical and other tramcars, motorcars, and such like vehicles." J. W. Towle. Dated June 3rd, 1898. Relates to fenders for electrical and other tramcars, &c. A screen or net having a gun-metal frame, slides in channel iron guides, which are secured by trusses, and bolts to saddles or brackets carried by the journal boxes, and connected by rods. Stay rods are provided. The fender may be fixed in any position by clamps. 2 claims.

12,631. "Tell-tale indicator for electric mast-heads and side lights of ships." A. K. Turner. Dated June 6th, 1898. To indicate when mast-head and side lights are burning, the circuit of the lamp passes through a solenoid which attracts its armature, and completes a shunt circuit for an indicating lamp. If from any cause, such as the burning out of the lamp the current fails, the armature breaks circuit for the lamp and switches in a high resistance bell. 1 claim.

24,833. "Improvements in means for suspending electric motors on electrically-propelled vehicles." S. H. Short. Dated November 24th, 1898. Relates to means for suspending electromotors on electrically-propelled vehicles. A frame is sleeved on the driven axle and supported from the frame of the vehicle at its opposite side by a link, cross bar and springs. The motor or its casing is trunnioned on the frame and has projecting lugs engaging springs so that the relations of the spur wheels on the armature shaft and driven axle are not interfered with. 4 claims.

24,855. "Improvements in apparatus for electrically transmitting orders or signals, suitable for use as a ship's telegraph and the like." A. N. Alcock. Dated November 24th, 1898. Relates to electrical apparatus for transmitting orders or signals from one place to another, and is suitable for use as a ship's telegraph, &c. The invention is described with reference to diagrams, and is too complicated for purposes of abridgment. 6 claims.

24,859. "Improvements in electric sparking plugs for explosion engines or motors." F. R. Simms. Dated November 24th, 1898. The fixed igniting terminal is insulated from the plug by a coating of hard enamel packed with asbestos and secured by cones and a nut of metal or porcelain which is protected by a casing and insulating cover secured by a nut. The conductor is secured by nuts or by a nut, and the cock which supplies benzine at starting through the hollow terminal, until the cylinder becomes warm enough to work with heavy oil. 5 claims.

24,887. "An electric alarm clock specially applicable for use in public works and other institutions." T. Millar. Dated November 25th, 1898. Relates to alarms. An electric switch is closed by a bell-crank lever bearing pins which engage in notches in three discs rotating respectively in seven days, half a day, and an hour. 2 claims.

24,949. "A regulating transformer for rotary phase current or polyphase current installations." Siemens Bros. & Co., Ltd. Dated November 25th, 1898. Relates to a transformer apparatus for regulating currents in polyphase current systems. The preferred arrangements for regulating the pressure in the leads supplied from a network is described. The inner ring (of an induction motor) is wound in three points and connected between each winding to the network. The outer ring is similarly wound, and connected to both sets of leads. A rotating field is produced in the inner ring, and induces electromotive force in the coils on the outer ring. This may be in phase or out of phase with the electromotive force impressed by the connection with the leads according to the relative positions of the coils on the two rings. Thus, by rotating the inner ring, the electromotive force impressed on the leads may be varied within limits. When using an induction motor, the rotor is prevented from rotating by means of a brake, and its position may be regulated by hand or by suitable automatic means. In modified arrangements, the coils on the inner ring may be connected to the leads or this ring may be fixed, and the outer ring movable. 1 claim.

24,965. "A new or improved electrical resistance measuring instrument." G. T. Hanchett and F. B. Sage. Dated November 26th, 1898. Relates to Wheatstone bridges. A box contains a battery and a compartment closed by a slide, to hold a telephone or other indicator, a hand key, and flexible connectors. Two arms of the bridge are higher-resistance wires extended between three metal blocks. A third arm is a divided resistance, enclosed in the box, and connected at one end to the block, and at other points to blocks; either of the blocks may be plugged to a bar. The fourth arm is the resistance to be measured, connected between terminals on the block and bar. The battery may be connected to the blocks by pressing contact springs provided on the hand key. This also carries an end-piece which may be applied to any point on the wires. The telephone is connected to the end piece and the bar. A strip is provided to support the operator's hand. The top of the box is graduated to read directly in ohms. 6 claims.

24,982. "Improvements in appliances for overhead electric traction." W. R. Smith. Dated November 6th, 1898. Relates to electric traction of vehicles on rails or on roads, the current being supplied by overhead conductors. The supply and return conductors are mounted in a horizontal overhead conduit slotted on the underside and supported from cables or from brackets at curves. The current is taken by the flanged wheels of a trolley, the wheels on the opposite sides being insulated and being connected through spring plates acting as brushes and flexible cables to the motor on the vehicle. At the points, a short length of the conduit works laterally on a vertical hinge or its roof, and is thrown to one side or the other by electro-magnets on the trolley engaging spring plates on the sides of the conduit, either magnet being excited according to the desired direction. At crossings, the conduits are mitred together on the same level, with insulated rail lengths and bye-pass wires. Hinged sections of the conduit are provided at intervals so that the trolley may be introduced or removed from the conduit by means of a tray mounted on a telescopic stand on the vehicle. The flexible conductors are led over adjustably-weighted pulleys or a spring-wound drum to take up their slack. To adapt flangeless wheeled vehicles, such as omnibuses, for electric propulsion, the front wheels are replaced by a three-wheeled motor truck working on the same swivel pin. The front wheel steers, and the others are driving wheels with the motor. 9 claims.

24,992. "Improvements in telegraphic receivers." G. Giorgi. Dated November 26th, 1898. Relates to Morse receivers in which the take-up drum is mounted on a shaft provided with a brake disc between the drum and the driving electromotor. The brake lever is mounted on a pivoted lever having an extension arm provided with an insulating piece. The piece is moved by a screw in the heel of the printing lever, and makes and breaks the circuit of the driving motor. The shaft is provided with a cam disc for moving the inking writing discs laterally by means of a pivoted lever. 2 claims.

25,068. "Improvements in electrical cut-outs." H. G. Solomon. Dated November 28th, 1898. Relates to a construction of fuse in which a second fusible strip is immediately and automatically put into the circuit when the first one blows. In one form a bar is connected to one terminal and the main fuse connects it with a bar pivoted on a spindle connected to the other terminal. A second fuse connects the bar with a contact fitted with a stop. A contact-lever is also pivoted and is rigidly connected to an arm which normally is also fixed to the bar by a pin fitted with a handle. When the fuse blows, the spring pulls round the arm and with it the levers. The circuit is thus completed through the second fuse. 2 claims.

25,095. "An improved conductor for submarine cables." G. M. Hardingham Dated November 28th, 1898. Relates to submarine cables in which the core is formed by a solid core surrounded by a layer of curved strips laid on spirally so as to closely fit the central conductor and to form a smooth outer surface. The core is insulated with gutta-percha. 1 claim.

25,098. "Improvements in electric surface contact tramways." S. P. Thompson. Dated November 28th, 1898. Electric railways and tramways on a road-contact system with electro-magnetic switches. In addition to the contacts and conductor for supplying current, a second row of studs and a conductor is provided for the return in systems such as are described in Specifications Nos. 19,455A and 19,456, A.D. 1896, and in Nos. 14,252 and 18,416, A.D. 1897. The studs may be connected directly to the conductors or by extra contacts on the main switches, or by a separate set of switches described in the above-mentioned specifications. 2 claims.

25,217. "Improvements in and relating to the production of electric currents." R. Eckermeyer. Dated November 29th, 1898. In staircase lighting and other small installations, a dynamo is driven by means of a spring and a train of wheels, and is arranged in parallel circuit with a secondary battery. On closing the switch an electro-magnet attracts a rod against the action of a spring, releases a stop pin on the wheel, and starts the dynamo. When the magnet circuit is broken, the rod drops into the path of the pin and stops the dynamo. 2 claims.

25,259. "Improvements in electrical speed indicators." R. Obst. Dated November 30th, 1898. The shaft, the speed of which is to be indicated, carries a wheel driving an electro-motor. The current is conveyed to a coil, which, according to the speed, draws in more or less of the suspended core, and by means of the pointer on its axis, indicates the speed. 2 claims.

25,302. "Improved means for supplying and controlling the supply of power to electric motors." J. Y. Johnson. Dated November 30th, 1898. Relates to means for supplying and controlling the supply of power to electric motors. The invention has for object to avoid the difficulties due to overloading, to cut off the motive power on the application of the brakes, and to render it impossible when power has been cut off to re-supply the motor with power except by commencing at the zero or minimum point and increasing as required. A controller regulates the supply of current to the motor. In the circuit there is a switch having one jaw stationary and the other pressed outwards by a spring, and kept closed by a latch and pin. The lug on the controller presses against a cam-like projection on the movable jaw when the controller is in the zero position. The solenoid is so constructed that, when the current passes through the thin wire, as when the brake lever makes contact with the terminals, the supported core is raised and pushes up the latch, and so operates the switch. On the imposition of an overload the excess current passing over the main line advances the core of the solenoid and so breaks the circuit, as explained above. 12 claims.

25,314. "Improvements in apparatus for transforming alternating into continuous electrical currents and conversely." C. D. Abel. Dated November 30th, 1898. Relates to reversible apparatus for converting alternating and direct currents. In the machine forming the invention and adapted for simple alternating currents, one of the windings is dispensed with, and the part of the apparatus rotates as a synchronous motor. The stator is fitted with six bobbins, each having a sinusoidal winding. Additional windings are fitted in notches and produce intermediate poles. The motor is fitted with bolts and copper rings and with crossed windings, one in series with the external circuit for the continuous current, and the other in shunt with the collector. The axle of the machine carries the rings for these currents, and also rings for connecting the segments and brushes for taking off the continuous current. 1 claim.

25,417. "A switch for electric circuits." J. Eck. Dated December 2nd, 1898. Switches adapted to control several circuits from one handle. A number of contacts are fixed upon a base-plate. The movable contacts are fixed on rods having a longitudinal movement which is controlled by the lever. Each rod is connected to the lever by a spring and the rods are connected together by a slotted frame. Positive movement is given to the rods by the lever striking the frame, and a quick break is given by the springs. All the circuits are broken when the lever is in the middle position. The contacts are preferably insulated from the rods, which are also insulated from the lever, thus giving a double insulation. 4 claims.

25,479. "Electric igniter or sparker for gas, oil, or vapour engines." F. W. Canfield. Dated December 2nd, 1898. To prevent failure of ignition when electrical igniters are used, owing to the current passing through the deposit that accumulates around the sparking terminals, a recess is formed in the insulation deep enough to prevent the combustible gases from coming in contact with its surface and forming a deposit thereon. Several forms of recess are described. 2 claims.

25,567. "Apparatus for transmitting motion to a distance by means of electrical energy." Siemens Bros. & Co. (Siemens & Halske, Aktien Gesellschaft.) Dated December 3rd, 1898. Relates to the electric step-by-step transmission of motion in either direction by means of rotary phase currents. The apparatus is similar to that described in Specification No. 8,041, A.D. 1897, except that each motor is double. The two individual motors on each shaft have their fields reversed. 1 claim.

25,676. "Improvements in electrical induction apparatus." S. B. Rimraide. Dated December 6th, 1898. Induction coils adapted for producing currents of very high frequency. Both the primary and secondary coils are wound as flat discs, and the primary is arranged near the periphery of the secondary. In arrangements with more than one primary and secondary coils, the terminals of the secondary are connected to the centre of the coils. The box is preferably fitted with a removable top and bottom and a central partition. The primary coils consist of a few turns of coarse wire or ribbon, and are connected in series. The secondary coils are also connected in series, and are separated from the primary coils by a glass or like plate. They are supported in position during construction by glass or similar rods, which form a grid and so prevent distortion. When the coils, &c., are in, the box is filled up with a fusible insulating material. The wire connecting the two coils may be connected to a socket for an additional terminal. In a simpler construction, with only one secondary, one terminal is connected to the centre of the coil and the other to the periphery. In a modification, pluralities of coils are employed, each primary enclosing a secondary. 10 claims.

22,037. "An improved machine for wrapping thread, silk, and other workable materials round wire, rod, or cord lengths, especially applicable for wrapping electrical conducting wire." W. P. Thompson. (J. Schmidt.) Dated October 19th, 1898. Electric conductors and other wires and rods or cords, &c., are covered with thread or other material in an apparatus consisting of a hollow spindle through which the wire, &c., passes, and on which a hollow shaft runs. The shaft carries a driving pulley and tightly fitting bobbin for the thread, &c. A concentric guide-ring is mounted on the frame, and is provided with a freely-moving rider through which the covering-thread passes. The wire, &c., does not rotate, but is fed longitudinally. The spindle is provided with right and left handed helical grooves, to act as lubricating channels. 3 claims.

22,079. "Improvements in and connected with carbon brushes for dynamo-electric machines or motors." The British Thomson-Houston Company, Limited. (A. L. Rohrer.) Dated October 20th, 1898. Relates to brushes. For the purpose of attaching a conductor to a carbon brush, the brush is cut away to receive a clip formed with a loop into which the conductor is compressed. The cut away part of the brush is electroplated and the clip soldered thereto, after which the joint may be electroplated. 8 claims.